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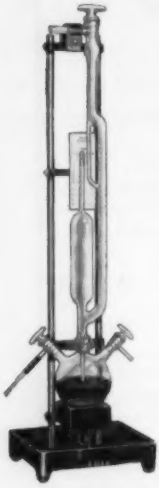

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Three Annual Reports

OF THE numerous annual reports that have reached the editorial office of the AAAS in recent weeks it would be difficult to select three that are more divergent than the *82nd Annual Report of the American Museum of Natural History,* the *Annual Report for 1951* (presumably the 41st) of the Carnegie Corporation of New York, and the *First Annual Report of the National Science Foundation.*

Founded in 1869, the Museum has built up a modest endowment of $16,000,000, has a budget approximating $3,000,000, and a gross income of $2,800,000, of which $1,000,000 is contributed by the City of New York. Dealing essentially with specimens and with their original functional role in nature, the Museum staff is not only concerned with scientific exposition and popular display, but also with those fundamental aspects of pure science—evolution and ecology—which give meaning, order, and educational value to collections that have been painstakingly and imaginatively assembled over a period of 82 years.

Unlike the American Museum of Natural History, the Carnegie Corporation of New York is backed by a basic endowment of $135,000,000, which good management has increased to $160,000,000. In the year ended September 30, 1951, $6,435,944 was disbursed for the "advancement and diffusion of knowledge and understanding." Believing that established institutions are best equipped to carry out these functions, the trustees gave 70 per cent of the total to universities and colleges, and substantial fractions of it went to aid the "uncommitted investigator," to accelerate the tempo of research in the social sciences, to improve education, and to find and develop administrative talent.

The National Science Foundation has, as is to be expected, little to report but much to sell. Created by act of Congress on May 10, 1950, it had no formal existence until its board was appointed and held its first meeting on December 12, 1950. It had no director until April 6, 1951, and its first fiscal year ended June 30, 1951, with $152,951 of its $225,000 appropriation obligated. The appropriation troubles of its second year are well known to readers of SCIENCE, and it now faces budgetary uncertainties for its third year beginning July 1, 1952. Congress will do well to ponder the slender 31-page annual report.

Entrusted with the important task of promoting and supporting basic research and education in the sciences, its financial resources for the current fiscal year are 0.14 per cent of this country's total expenditure for research and development, a scant 60 per cent of the funds available to the Carnegie Corporation, and only 16 2/3 per cent more than is expended to operate New York City's American Museum of Natural History. Like the Carnegie Corporation, the Foundation stresses the fact that discoveries in science are in the same category as wildcat drilling for oil, and that the surest approach to success is through the discovery and development of latent talent in every part of the nation.

Noting the study of Knapp and Goodrich (SCIENCE, **113**, 543 [1951]), in which the vital contribution of first-class brainpower on the part of the small liberal arts colleges was so effectively demonstrated, the report pledges Foundation aid to small institutions to enable them to train more and better men with better facilities. Except to those who direct research or train researchers, it is not easy to sell the thought that results are a function of individual talent, carefully schooled under optimum conditions. Yet this point of view is clearly a cardinal principle that guides the trustees of the Carnegie Corporation, and it is the keystone of the American Museum's program and success. It is to be hoped that the Congress will take its cue from privately supported institutions and give adequate public support to the organization that can do most to evolve a national science policy and world leadership in science and technology.

H. A. MEYERHOFF

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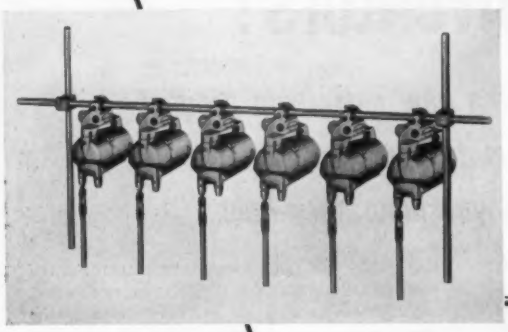

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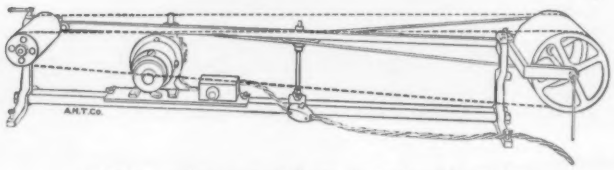
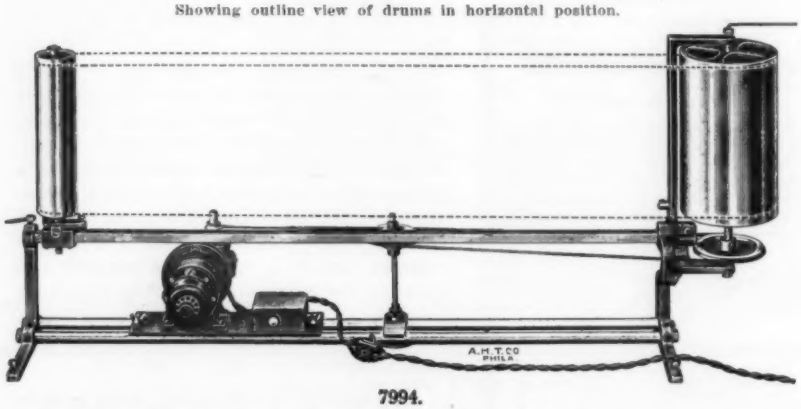


Showing outline view of drums in horizontal position.



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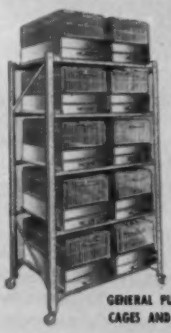

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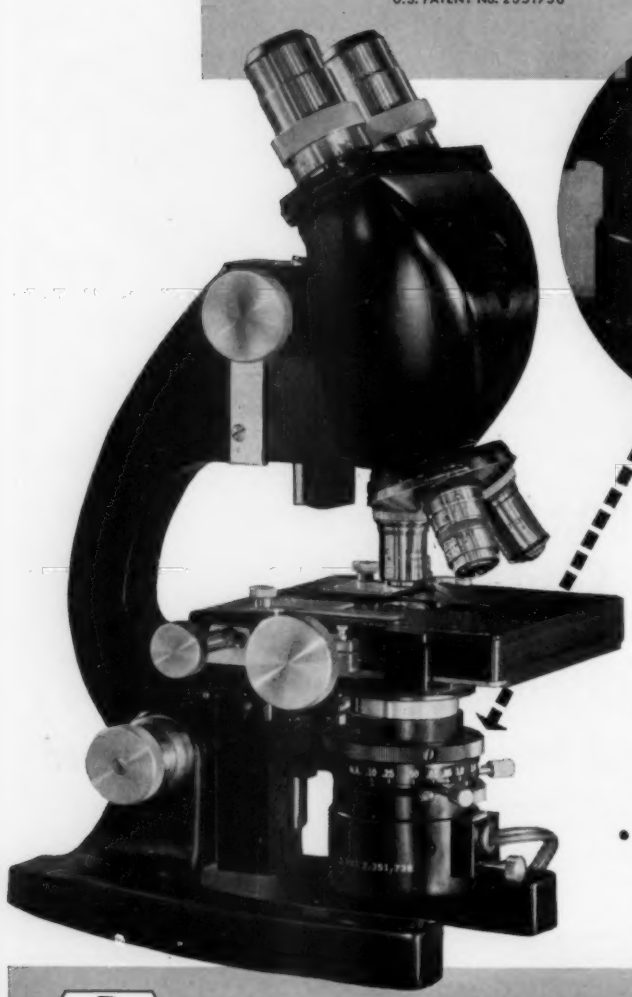

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Biological Processes in the Formation of Wood[1]

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DURING THE PAST CENTURY AND A HALF, data regarding the anatomical structure, the physical properties, the chemical composition, and the physiological functioning of wood have accumulated in ever-increasing volume. In recent years, owing to the rapid diversification of science in narrowing fields of intensive specialization, it is difficult for a single individual to become thoroughly familiar with all these data and to visualize their true significance in a broadening front of research. It is essential, however, that evidence obtained by new techniques be interpreted in harmony with summations of previously acquired knowledge. Much of the confusion and controversy during the past two decades regarding both the microscopic and the submicroscopic structure of wood could have been avoided, and more rapid progress could have been made, by broadened syntheses of available information and by closer integration of the researches of investigators in different scientific disciplines.

In view of such facts as these, it is advisable to summarize a number of salient generalizations that can be made at present regarding the development and the structural composition of wood. Extensive surveys of the plant kingdom, covering both living and fossil forms, indicate that fundamentally significant structural and physiological changes occurred when plants passed from an essentially aquatic to a truly terrestrial habitat. In the case of the so-called land plants —where photosynthesis occurs in parts elevated above the water level, where carbon dioxide is obtained directly from the atmosphere, and where water containing nitrogen and various essential minerals is moved upward from the soil to the transpiring green parts—tissues for facilitating rapid movement of sap and of enhanced mechanical strength are essential. Thus, all the land plants characteristically form tracheary cells, which serve to differentiate these plants, the Tracheophyta, from algae, fungi, and other lower forms.

Tracheary cells, the ubiquitous constituents of xylem or wood, serve as channels for a relatively rapid movement of water from the subterranean, absorbing rootlets to the aerial, transpiring leaves, and simultaneously impart a varying degree of rigidity and strength to parts of the plant in which they occur. It is highly significant in this connection, however, that the two functions are to a considerable degree mutually antagonistic, because certain structural features that enhance rapid conduction tend to weaken the cells and, conversely, others that strengthen them retard the movement of sap from cell to cell.

Primitive forms of tracheary cells are more or less extensively elongated and lose their living contents at functional maturity—two morphological features that enhance longitudinal movement of water in the woody tissue. Strength and rigidity are provided by a lignified secondary wall, formed internal to the original, delicate, primary wall, which alone is present throughout the earlier stages of cellular differentiation. The secondary wall inhibits a rapid movement of water from cell to cell and, therefore, must have holes or pits to facilitate such movement. The pit pairs of adjacent tracheary cells, in contrast to those of other forms of strengthening cells, are of a distinctive bordered form and are essentially an adaptation for exposing maximal areas of tenuous, unlignified, and relatively permeable primary wall without unduly enlarging the holes in the secondary wall. They have attracted much attention in botanical literature and are particularly significant in the preservative treatment of timber.

It is evident, accordingly, that conduction is enhanced in primitive forms of wood by increasing the number of bordered pits in the walls of the tracheary cells, but that the breaking strength of these elements is inversely proportional to the number of such pits per unit area.

The volume of wood in early land plants is relatively low in most cases, but the bordered pits in the secondary walls of the tracheids are very numerous and closely crowded. The woody tissue is thus efficient in conduction but is comparatively weak. With increasing height of land plants, the problem of attaining an adequate equilibrium between water lost by the leaves and water supplied by the roots without losing mechanical strength in the stems became a critical one. The solutions of this problem attained by evolutionary experimentation during the development of the vast array of modern land plants are highly diversified and are significant from both theoretical and practical points of view.

One means of strengthening the stem without reducing conduction in the wood is by the formation of cells with thick secondary walls in other tissues—e.g.,

[1] Invitation paper, read in a symposium on "The Chemistry of Wood," Cellulose Division, American Chemical Society, New York, September 6, 1951.

in the bast or the cortex. Since such additional strengthening elements are not actively concerned in the conduction of sap, their secondary walls may become very thick, and pits may be held to a minimum both as regards size and number. Among the flowering plants, bast fibers (closely associated with tracheary tissue in numerous independent strands) are particularly significant as strengthening elements in the monocotyledons—i.e., palms, yuccas, grasses, sedges, bamboos, etc.—and provide a source of much industrially important material.

In the case of the gymnosperms, particularly the so-called evergreen or cone-bearing trees, an equilibrium between transpiration, conduction, and strength is attained in a fundamentally different manner. Conduction and strength in the stems and roots are simultaneously enhanced by progressively increasing the volume of wood as the trees grow larger. This is accomplished through the activity of a jacketing layer of meristematic tissue, the cambium, which forms new increments of wood each growing season. The tracheary cells of the laterally enlarging cylinder of wood vary more or less markedly in length, in cross-sectional area, in thickness of their secondary walls, and in the number, size, and arrangement of the bordered pits in their radial surfaces. Certain of these structural differences are evidently correlated with variations in the equilibrium between transpiration, conduction, and strength during the successive stages of enlargement of the tree. The most striking structural contrasts occur where cambial activity is intermittent —i.e., where the cambium is inactive during the winter or during a prolonged dry season. In such coniferous species, the tracheids formed during the early part of the growing season have a larger cross-sectional area and have thinner walls with larger and more numerous bordered pits, in contrast to the tracheary cells formed later in the growing season, which have smaller diameters, much thicker secondary walls, and a few rudimentary pits only. The weakness of the permeable early wood is obviously compensated by the markedly increased density and strength of the late wood.

It is in the arborescent dicotyledons, or so-called broad-leaved trees, however, that division of labor among tracheary cells attains its highest level of specialization. These are flowering plants, but, like the coniferous trees, they also have cambial activity. Because of their broader leaves, they have comparatively high transpiration, and there is a complete series of successive evolutionary stages in the development of vessels—long, open, tubelike conducting passageways —from vertical series of apically contiguous tracheids, the essential structural change being the dissolution at functional maturity of the primary walls in the bordered pit pairs of the contiguous tracheary cells. Closely paralleling the development of these channels of accelerated conduction within the wood are concomitant structural changes in the general residue of imperforate tracheids, leading to progressive accentuation of their mechanical function and to elimination of their role in conduction. The end products of this trend of specialization have reduced diameters, thick secondary walls, and small pits without borders. They resemble bast fibers rather than tracheary cells. In many cases, these so-called libriform fibers of the wood retain their living contents at maturity and assume a storage function in addition to a mechanical one.

The wood formed by the cambium in gymnosperms and dicotyledons is not composed solely of tracheary cells but contains varying proportions of parenchymatous elements, which retain their living contents for many years in the mature sapwood. These living cells differ fundamentally in size, form, and structure from the tracheary ones. They may have a primary wall only, of varying thickness and degree of lignification, as in the cedars, cypresses, redwood, etc.; or they may have an additional lignified secondary wall, as in the spruces, larches, firs, and a majority of the broad-leaved trees. They function in the synthesis and storage of starch, fat, and many other organic substances. Those of the rays facilitate radial movements of water, sugars, and various elaborated compounds forward and backward between the bast and the wood.

At this point, I anticipate considerable skepticism regarding the significance of such biological data in a symposium on the chemistry of wood. It is essential, however, that the biochemist and the biophysicist be fully cognizant of the variables in the material that they are attempting to analyze. Wood, particularly that formed in industrially significant quantity by cambial activity, is exceedingly complex and highly variable, as I have indicated, not only in different groups of land plants, but also within different parts of a single tree. Therefore, generalizations regarding the chemical composition or the physical structure of wood, or of its constituent cells, must be verified by the study of a wide range of material, to be valid and of general utility. Gross chemical analyses of wood have yielded information of great economic value, but it is becoming increasingly desirable to determine from what part of the wood each organic residue is obtained, its form and relationships when *in situ*, and the changes that it undergoes during removal.

Fourteen years ago, in a symposium of this division held at Chapel Hill, North Carolina, I summarized evidence that had accumulated regarding the microscopic, and certain phases of the submicroscopic, composition of the walls of plant cells. I shall not attempt at this time to review this evidence, since it has already been published in detail (*1*), but shall merely reemphasize certain generalizations that were formulated at that time.

In dealing with tracheary cells, as with bast and cortical fibers, stone cells, and the hairs of the cotton plant, one is concerned with two fundamentally different types of cell walls. The cells of the cambium, as of the apical meristems and such of their derivatives as retain a capacity for growth and for increase

in volume, are characterized by having a wall that is capable of increasing in surface area and of undergoing reversible changes in thickness. Tracheary cells and fibers that undergo various irreversible changes during their maturation and thus lose their potentialities for growth and enlargement retain this original primary wall in a more or less modified condition, but form in addition a secondary wall of a supplementary strengthening character. The cellulosic matrix of both types of walls is composed, not of discrete particles, such as have frequently been hypothesized in the earlier literature, but of a coherent, continuous system of microfibrils. In the case of the secondary wall, where these fibrillar aggregates of chain molecules commonly are less than 500 A units in diameter, it is possible to make them visible under an ordinary microscope by carefully controlled swelling techniques and to study their configurations with considerable clarity of detail. It is no longer possible to brush them casually aside as artifacts, for their significance is now being verified by the electron microscope.

In the secondary wall, in contrast to the tenuous primary one, the microfibrils are relatively compactly arranged parallel to one another in strongly preferred orientations. The tracheids formed by the cambium in both coniferous and dicotyledonous trees commonly have a three-layered secondary wall, the fibrils of the inner and outer layers—except in the borders of the pits—being transversely oriented or in helices of relatively low pitch, whereas those of the central layer are arranged longitudinally or in helices of comparatively steep pitch. The inner and outer layers are tenuous, and fluctuations in the thickness of the secondary wall are due primarily to variations in the width of the central layer. Deviations from this typical three-ply structure occur, however, in certain modified types of tracheary cells—e.g., in the tracheids of the so-called compression wood of conifers, in the members of highly specialized forms of vessels, and in the more fiberlike elements of certain dicotyledonous woods. Such deviations may consist of multiple layering resulting from repeatedly changing preferred orientations, or from one or more discontinuities in the cellulosic matrix that are due to the deposition of noncellulosic layers.

Within the secondary wall the microfibrils of anisotropic cellulose are not uniformly distributed throughout, but in the broader central layer, at least, they are aggregated in patterns of varying density or porosity —at times, in concentric lamellae resembling the diurnal ones of the cotton hair and, at others, in radial configurations of varying complexity. The interstices between the microfibrils form a continuous system of elongated microcapillaries oriented parallel to the microfibrils. Lignin is deposited within these microcapillaries and, where it is abundant, forms a continuous system of anastomosing strands that persists as a coherent residue after chemical removal of the cellulose. Thus, the secondary wall of heavily lignified tracheary cells consists at maturity of two continuous interpenetrating systems of remarkably similar configuration, one of cellulose and the other of lignin.

The intensity of lignification varies not only in different groups and species of the land plants, but also in different cells of the same sample of wood and in different parts of the same cell. In general, the tracheids of coniferous woods and the vessel members of dicotyledonous ones—cells in which the conducting function is strongly emphasized—are heavily lignified, the tenuous primary wall, except in the membranes of the bordered pits, and the thin inner and outer layers of the secondary wall commonly being more intensely lignified than the central layer of the secondary wall. In contrast, the fiber tracheids and libriform fibers of dicotyledonous woods—cells in which the mechanical function is dominant—usually, but not invariably, are less intensely lignified, the difference being due largely to lighter lignification of the broad central layer of the secondary walls of these cells. It should be emphasized in passing that these diversified, internal fluctuations in the lignification of wood are particularly significant in the extraction of organic constituents by standardized chemical procedures and in the degradation of wood through the activity of fungi and bacteria. It should be mentioned that recent investigations (*2*) of wood, where the hydrolysis of cellulose is gradual and without conspicuous swelling of the material, provide data of considerable significance in any summation of evidence regarding structure and chemical behavior.

Although we are gradually acquiring reliable information regarding the form and distribution of cellulose and lignin in wood, less progress is being made with other organic constituents, particularly the pectic compounds and hemicelluloses of various kinds. The unlignified primary walls of cells that are capable of growth and enlargement, such as the cambial initials and their tracheary derivatives during the earlier stages of their maturation, certainly contain, in addition to cellulose, galactose, galacturonic acid, arabinose, and usually if not invariably, a relatively large proportion of protopectin. The intercellular substance between the primary walls of adjacent cells is composed, it is generally believed, of calcium pectate. There is considerable cumulative evidence that indicates that the polyuronides of the primary wall and of the intercellular substance are not replaced by lignin during the later stages of the development of wood, but persist in the mature tissue. It should be recognized in this connection that the volume of primary walls and of the intercellular substance in mature wood is so slight in comparison with that of the secondary wall that, unless the latter wall contains pectic substances, the proportion of such substances obtainable in gross analyses must be very low. Small yields of pectin can be obtained by careful analyses, at least from dicotyledonous woods.

There is no conclusive evidence, except possibly in certain aberrant types of tracheary cells, of the physiological utilization of the series galactose, galacturonic acid, and arabinose during the formation of the secondary wall. In many dicotyledonous woods

there is, on the contrary, a physiological state involving glucose, glucuronic acid, and xylose.

Cumulative evidence tends to indicate that the polyuronide hemicelluloses of the secondary wall are deposited in the microcapillaries in close association with lignin; that certain polyoses of Norman's terminology may occur at times in the cavities of cells, rather than in their walls, and that the cellulosans are intimately associated in some manner with the cellulosic matrix; but the exact configurations of these substances, when *in situ*, are relatively obscure.

In conclusion, I should comment upon the unsatisfactory state of available information regarding the biochemical reactions that occur in the cambium and during successive stages in the development of fully matured wood.

There are six significant regions in the development of the woody cylinder of a tree. As seen in a cross section of a stem, these are in centripetal succession: (1) the cambial zone or region of cell multiplication, of the synthesis of protoplasm, and the formation of primary walls; (2) a zone of cell enlargement and increase in surface area of the primary walls; (3) a zone of maturation, involving in tracheary cells the formation and lignification of a secondary wall and culminating in the dissolution of their living contents; (4) a zone of fully matured sapwood containing, in addition to tracheary cells, living parenchymatous elements that function in the formation of many complex substances and in the storage of starch, fat, and other potential sources of food; (5) a zone of transformation of sapwood into heartwood, where diversified substances formed by the expiring parenchymatous cells saturate the wood; and (6) an inner core of heartwood, which contains no living cells and is chemically inert.

Owing to strong industrial stimulation, chemical research has been focused largely upon the heartwood and upon sapwood, the living cells of which have died subsequent to the felling of the tree. Furthermore, there has been a tendency to concentrate upon the study of tracheary and fiberlike cells, and to overlook the significance of parenchymatous cells as sources of certain fractions of the organic substances obtained in chemical analyses of wood as a whole. Plant physiologists, in investigating the complex biochemical processes in living cells, have naturally been inclined to deal primarily with plants of relatively small size that can be more easily grown and studied under controlled experimental conditions. Thus, there is a serious dearth of reliable information regarding the diversified biochemical reactions that occur in the living cells of the cambium, of the two succeeding zones of tissue differentiation, and of the mature sapwood. It should be recognized, in addition, that there are inherent difficulties, owing to spatial relations and cellular configurations, in studying the biochemical activities in these parts of a tree.

Under normal conditions, organic substances essential for cambial activity and the development of wood are formed in the leaves and move downward in the bast. The mechanism of rapid movement in the phloem is obscure, and the subject has been the source of much recent controversy. That photosynthesis is not indispensable in the development of wood is indicated by the demonstrated possibility of growing plants in the dark, if they are provided with an adequate supply of sucrose (*3*). Tall, etiolated sunflower plants grown under these conditions form a relatively wide zone of lignified wood. There is a summation of evidence, however, which indicates that in trees of northern environments cambial activity is activated in the spring by a downward flow of auxin from the expanding buds. It should be possible by suitable modifications of experiments with etiolated plants—supported by comparable experimentation with green ones—to determine what substances can be formed by the cambium and its living derivatives, and which ones, if any, must be obtained at all times from other parts of the plant.

Although much can be learned by such methodologies as these concerning substances essential in the development of wood, the complexities of their biochemical utilization—for example, in the formation of cell walls—must ultimately be studied in the living cells themselves. It is in this connection that the spatial relations and cellular configurations referred to in a preceding paragraph become so significant. The cells of the cambium commonly fluctuate between 4 and 8 microns in radial diameter. In slowly growing trees, the cambium consists of a single circumferential row of initials; i.e., it has a radial thickness of one cell, whereas in rapidly enlarging stems there may be two to three rows of actively dividing cells. In any case, the cambium of our common coniferous and broad-leaved trees usually does not exceed 24 microns in thickness. The zone of cell enlargement and the succeeding stages in the maturation of the sapwood may at times be considerably broader than this, but still are of relatively microscopic thickness. It is evident, accordingly, that there are inherent difficulties in removing part of any one of the successive layers and of studying it dissociated from adjacent layers. Thus, analyses of the cambium that have been reported in the literature actually are based upon a complex of cells, only a minor fraction of which are truly cambial. Similarly, so-called tissue cultures of the cambium are derived from complexes of living cells, which include, in addition to cambial initials, tissue cells that are known to be capable of dedifferentiation and of subsequent division. Furthermore, when parts of the cambium are removed from a tree and are grown in tissue cultures, the initials cease to function normally and become involved in the formation of callus, such as is formed in nature in the healing of injuries, in graft unions, and in the rooting of cuttings.

Such illustrations as these serve to emphasize the complexities and difficulties involved in studying the vital biochemical reactions that occur during successive stages in the development of wood. Thus far, progress

in elucidating them has been disappointingly slow, owing in considerable part to a concentration of effort in studying their end products in fully matured wood, rather than the developmental processes themselves. However, the growth of forests on nonagricultural lands is so significant to the future welfare of man as potential sources of diversified organic substances and of stored solar energy that a sustained and comprehensive effort should now be made toward a better understanding of developmental processes in the formation of wood. To be successful such an effort must involve a much closer and broader integration of research in different scientific disciplines.

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News and Notes

Seminar on Social Processes in the Pacific

The Australian National University sponsored a Jubilee Seminar on Social Processes in the Pacific August 27–29 in Canberra, with the Research School of Pacific Studies as host. Following the formal opening of the seminar by Douglas Copland, Raymond Firth, of the University of London, outlined the aims of the conference. It was not intended for the presentation of papers on original work or the discussion or formulation of research plans as such. Rather it was designed to discuss and define problems of social process in the Pacific and to formulate hypotheses for further research.

Four keynote papers were presented as points of departure for discussions. The first of these was given by Margaret Mead on "The Changing Structure of the Family and Higher Kin Units." Dr. Mead noted that in the past anthropologists have focused their attention on the unique character of island groups and have tended to lose sight of the larger regularities, which transcend differences among culture areas such as Polynesia, Melanesia, etc. She suggested that a subject requiring study is the social organization of detribalized and deculturated natives. She further indicated that an investigation of native workers may reveal new forms of social organization based on kin patterns. The central question, Dr. Mead felt, was "How are old kin relationship patterns being used in newly created situations?" Future work in the Research School will involve the study of individual cultures under contact conditions. Dr. Mead concluded by pointing out that the Pacific is becoming an arena for clashing ideologies:

> It is possible that if adequate attention is given to the formal kinship patterns, in contrast to whatever new patterns of organization and allegiance are to be introduced, considerably greater integration of native character might be maintained, and some of the destructive accompaniments of culture contact prevented—for example, the extreme growth of *anomie*, and proletarianization and detribalization.

A. P. Elkin, University of Sydney, explored the concepts of social process in the Pacific. In the process of adaptation to changing environment, the task is to determine and isolate the factors involved. Elements concerned in the process are receptiveness toward outside influences and inventiveness within the group; hostility, which strengthens the cohesion of a community; isolationism in language, customs, values; the family, which is not strongly integrated within itself; larger kin groups. Examples of fatal attacks on the structure of society were cited in the usurpation of the aborigines' land and, in Melanesia, absence for long periods at work of marriageable men. Contact and clash in the Pacific have resulted in a double life—on one side the natives express need for European benefits, whereas on the other there are conflict and hostility toward European influence.

W. E. H. Stanner, Australian National University, described "The Economic Development of Pacific Peasant Peoples against their Social Background." He listed six important basic factors affecting development in the South Pacific: relative poverty of physical resources; small and usually ill-distributed populations; high incidence of disease, malnutrition, and illiteracy; primitive technological attainment; a prevalent traditionalist ethos; social structures of fairly simple differentiation. At the more immediate level one has to deal with the factors of low average production per head, low real or monetary income per head, low rate of capital investment per head, and a high maldistribution of income. All Pacific territories also share in what Dr. Stanner termed "typical" disabilities of the "colonial" type of economy. Pacific economic prospects are not promising. Some island situations are clearly antipathetic toward development, some are anomalous and thus make prediction difficult if not impossible, and a few show some developmental coherence. The developmental problem is to change the elements that have dominated the traditional island economic systems so that expanding systems can replace the characteristic island stationary systems.

> Unfortunately, the rate of population expansion over the next twenty years will probably be so high that the rate and scale of capital investment needed to maintain

existing standards will be higher than the administratively practicable rate. A realistic development policy for the Pacific Islands entails direct external aid in the vicinity of £20–£30 millions annually.

A. Grenfell Price, University of Adelaide, discussed "Geopolitical Transformation of the Pacific and its Present Significance." He presented a concise account of European expansion into the Pacific and suggested certain problems of human and historical geography that had developed. In concluding, Dr. Price outlined three fundamental problems:

(1) The increasing population in the Asiatic Pacific (and Indian Ocean) lands is allied with demands for better living conditions. This is probably the real strength of communism in Asia. Migration is no solution for population increments of the order involved and the outlook is gloomy. (2) Linked with the demographic problem is that of the destruction of resources through erosion and soil depletion. (3) Industrialization of Asian Pacific countries with great raw material and population resources, such as China, may lead to immediate population increases at an even greater rate than now prevails, and a repetition on a greater scale of the consequences of Japanese industrial expansion. On the other hand, industrialization has a positive part to play in assisting the intensification of agriculture, and the development of secondary industry may eventually assist in meeting population pressure.

The fourth keynote paper was presented by J. W. Davidson, Australian National University, who spoke on "The Changing Political Role of Pacific Islands Peoples." The scientific study of government in the Pacific Islands, he pointed out, is scarcely begun.

For the present, research must continue to be pragmatically organized, with the aim of developing adequate concepts for the more systematic study of dependent government later on. The inadequacy of the theoretical background makes it of special importance that the study of problems of government should go hand in hand with the understanding of other fields of social action.

Lively and profitable discussion followed the presentation of each paper. In summarizing the seminar, Chairman Firth noted that differences of opinion on principles and on stress had emerged, but that there had been general agreement on the importance of the problems arising from the subjects discussed. Especially noteworthy had been the complete equality of expression as between theoretical scholars and area experts. The interdisciplinary nature of the conference had also been very valuable.

Among the many points emerging during the seminar was the need felt for more data of a numerical kind for the greater use of quantitative factors in the analyses of social processes. There was also agreement on the need for more field study of small units to allow for closer comparison and the isolation of specific variants. In the economic field, for instance, more careful study is needed of the resources of Pacific communities and the relation between these potentialities and what the populations themselves desire.

On the invitation of the chairman, visitors at the conference who represented various organizations interested in Pacific research commented on the activities of their respective organizations. A. P. Elkin spoke concerning the Australian National Research Council, the University of Sydney Research Committee and Department of Anthropology, and the Pacific Science Council of the Pacific Science Association; A. Capell, of the teaching of linguistics at the University of Sydney; E. Beaglehole, of the increasing awareness in New Zealand of the need for research, and of the Social Science Research Committee at Victoria University College; J. Guiart, of the Institut français d'oceanie; L. G. Hudson, of the Pacific Science Council Secretariat and Pacific Science Association; C. Rowley, of the Australian School of Pacific Administration; H. E. Maude, of the South Pacific Commission; and Dr. Mead, of some publications and outlets for publication, including *Human Organization* published by the Society for Applied Anthropology.

From Report of the Executive Secretary, Pacific Science Council Secretariat

Scientists in the News

J. B. Austin, director of research and chief of U. S. Steel's Research Laboratory at Kearny, N. J., has been appointed a member of the Committee on Chemical Warfare of the Department of Defense Research and Development Board. Dr. Austin has served the committee as an alternate member to **Randolph T. Major,** who is now chairman.

Hans A. Bethe and **Harry A. Winne** have been appointed members of the Committee on Atomic Energy, Research and Development Board. Dr. Bethe, professor of physics at Cornell University, was chief of the theoretical physics division of the Los Alamos Scientific Laboratory during 1943–46. Mr. Winne is vice president in charge of engineering policy, General Electric Company, Schenectady.

P. V. Cardon will serve as director of the Graduate School of the U. S. Department of Agriculture during the absence of **Lewis H. Rohrbaugh. O. B. Conaway, Jr.,** former assistant to the director, has been named assistant director. Dr. Cardon joined the Graduate School staff as assistant director on a part-time basis, Feb. 1, following his retirement as ARA administrator. He will fill the post of director while Dr. Rohrbaugh is on a two-year assignment as Point IV director for Iraq.

William G. Carr has been named to succeed **Willard E. Givens** as executive secretary of the National Education Association. Dr. Givens will retire Aug. 1 after 17 years of service. Dr. Carr has been associate secretary of the NEA since 1940, and secretary of the Educational Policies Commission of the NEA and of the American Association of School Administrators since 1936.

The 1952 award of the Commercial Chemical De-

velopment Association will be given to **John P. Coe,** vice president and general manager of the Naugatuck chemical division of the United States Rubber Company. The award is presented annually to the person in the chemical and chemical process industries who has performed outstanding service and work in commercial chemical development.

A policy dispute in the Veterans Administration has prompted the resignation of **E. H. Cushing** as assistant chief medical director. Vice Admiral Joel T. Boone, VA medical chief, expressed surprise at Dr. Cushing's resignation because only last September the doctor accepted a four-year reappointment as head of the medical research and education programs. Dr. Boone named **George Marshall Lyon** to replace Dr. Cushing. Dr. Lyon has directed the agency's radioisotope research program.

The Mathewson Gold Medal was awarded by the American Institute of Mining and Metallurgical Engineers to three laboratory employees in General Electric Company's Transformer and Allied Products Division and to one former employee for outstanding achievement in the field of metallurgy. Recipients were **Cecil G. Dunn, Franklin W. Daniels,** and **Michael J. Bolton,** of GE's Laboratory Engineering Department, Pittsfield, Mass., and **Fabian Lionetti,** who is currently a biochemistry instructor at the Boston University School of Medicine. The Mathewson Medal is awarded for the paper or series of closely related papers with at least one common author, which represents the most notable contribution to metallurgical science in the three-year period preceding the award. This year's winners discovered some of the factors that control the growth of crystals in metals, and their findings are especially useful in transformer manufacture, where the magnetic properties of steel used in transformer core structures depend entirely upon the growth of a certain kind of crystal during heat treatment.

Henry C. Falk, director of gynecology and obstetrics, Beth Israel Hospital, and clinical professor of gynecology, New York University Graduate School of Medicine, is in Israel making a six-week tour of the hospitals run by Hadassah, women's Zionist organization. Dr. Falk has been invited by the Medical Advisory Board of the Hebrew University–Hadassah Medical School to demonstrate certain types of gynecological surgery and to lecture to the Jerusalem Medical Society on pelvic inflammatory diseases. He will also demonstrate surgical techniques at government and other private hospitals in Israel.

Sinai Hospital of Baltimore will have **Harry Gordon** as full-time chief of staff in pediatrics. In accordance with a joint agreement recently entered into between Sinai and the Johns Hopkins medical institutions, Dr. Gordon was also appointed an associate professor in pediatrics at the Johns Hopkins Medical School and pediatrician on the staff of the Hopkins Hospital. Dr. Gordon resigned as professor of pediatrics at the University of Colorado School of Medicine and as pediatrician-in-chief at the Colorado General and Denver General hospitals to accept the Sinai appointment.

R. I. Higgins, of the British Cast Iron Research Association, is replacing **C. Wainwright** as metallurgical liaison officer at the United Kingdom Scientific Office, Washington, D. C. Mr. Wainwright has returned to England to resume his work at the National Physical Laboratory, Teddington.

Ferdinand Jehle, formerly with the Hoffman Specialty Company, is now secretary to the Indiana State Board of Registration for Professional Engineers and Land Surveyors at Indianapolis.

J. Wallace Joyce, deputy science adviser, Department of State, represented the U. S. government as an observer at the British Commonwealth Scientific Official Conference in Canberra and Melbourne, Australia. Primary purpose of the conference was to enable official scientists of the British Commonwealth countries to consider ways and means of ensuring the fullest possible collaboration among the government scientific organizations of the Commonwealth. It was anticipated that a U. S. observer might facilitate closer and more extensive liaison between American and Commonwealth scientists. Items considered included the development of scientific liaison offices, scientific representation abroad, methods of Commonwealth collaboration in science, relations with international organizations, and information and abstracting services.

W. McNeil Lowry, chief Washington correspondent for the Cox newspaper chain, has been appointed associate director of the International Press Institute. In his new post he will be directly concerned with research studies of the institute, which has its headquarters in Zurich. He will also edit the institute's monthly bulletin, *I. P. I. Report.* The institute, whose secretariat is supported by grants from the Ford and Rockefeller foundations (SCIENCE, **114**, 249 [1951]), is an organization of editors from the free countries of the world dedicated to the preservation and strengthening of the free press and to inquiry into problems of international journalism.

Malcolm S. McIlroy will be appointed assistant dean of the College of Engineering at Cornell, following the retirement of Assistant Deans **Walter L. Conwell** and **Robert F. Chamberlain** this summer. He will continue in his present capacity as assistant director of the School of Electrical Engineering until July 1.

T. C. Schneirla, curator, Department of Animal Behavior, American Museum of Natural History, and a group of three assistants are spending five months in the Canal Zone Biological Area, Barro Colorado Island. It is anticipated that the present expedition will conclude a 20-year project on the ecology and behavior of army ants of the genus *Eciton.* Accompanying Dr. Schneirla are **William B. Jackson,** of Johns Hopkins; **Carl Rettenmeyer,** of Swarthmore;

and **R. Elwood Logan,** American Museum photographer.

Kai Siegbahn has recently been appointed professor of physics at the Royal Institute of Technology (Kingl. Tekniska Hogskölan), Stockholm. There are now two professorships in physics at the institute, with **Guomund Borelius,** a solid-state physicist, occupying the other chair. It is expected that Dr. Siegbahn will continue to work closely with scientists at the Nobel Institute for Physics, where he has been for a number of years.

Samuel S. Stratton, president of Middlebury College, has been appointed director of Point IV technical assistance for Saudi Arabia.

Starr Thayer, a cathodic protection consultant of Houston, and **Earl A. Gulbransen,** advisory engineer to Westinghouse Research Laboratories, East Pittsburgh, Pa., have been designated to receive the annual Frank Newman Speller and Willis Rodney Whitney awards from the National Association of Corrosion Engineers. The awards will be presented Mar. 13 during the eighth annual Conference and Exhibition at Galveston. The Speller Award is given for achievement in corrosion engineering, and the Whitney Award for achievement in corrosion science.

George Wald, of the Biological Laboratory of Harvard University, will discuss "The Molecular Basis of Vision" (*cf.* SCIENCE, **113,** 287 [1951]; **115,** 60 [1952]) as a Sigma Xi national lecturer at a number of colleges and universities. His itinerary will take him from Illinois to California and back via the Southwest to Kansas and Missouri.

J. Alexander Webb, of Pitman, N. J., vice president of Abbotts Dairies of Philadelphia, has received the annual award of merit of the New Jersey milk industry in connection with Farmers Week. In making the presentation. William J. Russell, president of the New Jersey Milk Industry Association, praised Dr. Webb's contributions in reducing dairy herd tuberculosis and seeking solutions of the industry's problems.

Lewis G. Weeks, chief research geologist of the Standard Oil Company (N. J.) and vice president of the American Association of Petroleum Geologists, gave three talks on phases of "Basin Development and Oil Occurrence," at Maracaibo, Caripito, and Caracas, in the course of a recent trip to Venezuela.

W. Barry Wood, Jr., Busch professor of medicine at Washington University, recently served as the physician-in-chief pro tempore at the Peter Bent Brigham Hospital, Boston.

O. L. Zangwill, of the Institute of Experimental Psychology, Oxford, has been appointed to succeed **Frederic C. Bartlett** as professor of experimental psychology, University of Cambridge.

Education

In **Better School Design,** a nation-wide contest sponsored by *The School Executive,* five schools received top honors, four received special citations for outstanding merit, and 15 others honorable mention. The top five were the New Bangor (Me.) Elementary School; Mira Vista Elementary School, San Francisco; the Lido Beach School, Long Beach, N. Y.; the Rosedale Road School, Yonkers, N. Y.; and the Will Rogers School, Stillwater, Okla. In a second contest sponsored by the same journal, five schools were chosen winners in a **Competition for Community Improvement,** and five others were accorded honorable mention.

Harvard University, aided by a three-year grant from the Fund for the Advancement of Education (Ford Foundation), will begin a program of training for elementary and secondary school teachers in cooperation with 20 other Eastern colleges. Fellowships will be offered graduate students for a year of study at Harvard leading to the M.E. or the M.A. in teaching. The Ford Foundation is supporting the program with $45,000 per year for fellowships and $33,000 per year for costs of instruction and administration. Most educators agree that the project should stimulate able undergraduates to take up careers in teaching in the elementary and secondary schools, thus relieving the serious shortage of competent teachers.

The **University of Illinois** College of Education will offer for the first time a summer workshop for specialists in elementary education (June 23–July 19), which will carry one unit of graduate credit. Problems of administration, curriculum, supervision, public relations, and in-service training will be studied under the supervision of Fred P. Barnes, J. Harlan Shores, and Edwin H. Reeder (Illinois); H. M. Barr (Portland, Ore., director of research in the public schools); and O. M. Chute (Evanston, Ill., superintendent of grade schools). Professor Reeder will be chairman of the workshop.

A Rheumatoid Arthritis Rehabilitation Project at the **New York City Goldwater Memorial Hospital,** under the direction of Edward W. Lowman, will seek to determine the effect of cortisone therapy in conjunction with intensive rehabilitation procedures on severely disabled patients. Fifty patients, residents of New York City, and meeting a variety of other conditions, will be admitted in 1952 and in 1953.

At the **Texas Medical Center,** Houston, M. D. Anderson Hospital for Cancer Research will hold its sixth annual "Symposium on Fundamental Cancer Research" Apr. 25–26. During the same period a Cancer Pathology and Radiology Conference on "Tumors and other Diseases of Bone" will be held. The South Central Section of the College of American Pathologists will participate in both meetings. The third Bertner Foundation Lecture and Award will be features of a banquet in the Hotel Shamrock Apr. 25.

Grants and Fellowships

The **Alumni Fund of Michigan State College** is offering seven predoctoral fellowships ($800–$1200) and one postdoctoral fellowship ($300) to qualified candidates in any field of research for which Michigan State has the appropriate facilities. Inquiries should be addressed to the dean of the School of Graduate Studies. Completed applications must be received before *May 1*.

The **National Science Foundation** has approved 28 research grants, totaling $410,000, in the biological sciences. Grants ranged in amount from $780 (University of Minnesota, investigation of coal ball floras) to $50,000 (University of California, Berkeley, study of polygenic variability). The foundation will also support the operating expenses of the Pacific Science Board for two years ($24,000). The total allocation represents slightly less than 40 per cent of the funds available to the foundation for support of basic research for the current fiscal year. Additional proposals are being evaluated.

For the fiscal year beginning Apr. 1, the **National Tuberculosis Association** has approved 25 grants to aid research in the bacteriology and chemistry of the tubercle bacillus, anatomy and physiology of the lung, pathology and immunology of tuberculosis, experimental chemotherapy, clinical treatment of tuberculosis, and epidemiology of tuberculosis and related diseases. Eleven research and teaching fellowships were approved.

Applications for **Helen Gates Putnam Fellowships** in the Graduate Division of Conservation at Vassar will be accepted by the Plant Science Department until *Apr. 1*. The fellowships provide tuition and a stipend of $1200 in return for part-time assistance in the department.

The **A. H. Robins Co., Inc.**, of Richmond, Va., has underwritten a project at the Sperry Gyroscope Co. designed to investigate the medical relief of common pains of occupational origin. Initially 100 patients will be treated, after which the investigation may be extended.

The **Alexander and Margaret Steward Fund** has awarded grants totaling $45,184 to George Washington University for home care of cancer patients and to evaluate methods for treating cancer patients who are beyond help by routine surgical or x-ray therapy. Both grants will continue projects previously supported by the fund in the Cancer Clinic, under the direction of Calvin T. Klopp.

Vernay Laboratory, Inc., has established a one-year postdoctoral fellowship at Antioch College for research into the methods of synthesizing certain organic compounds containing silicon or fluorine. Clark Gage, of Yellow Springs, has been appointed to the fellowship for 1952 and will work under the direction of James F. Corwin.

Meetings and Elections

The **American Association of Petroleum Geologists**, meeting in Los Angeles Mar. 24–27, will install Morgan J. Davis, vice president and director in charge of exploration for Humble Oil and Refining, as president. Other 1952–53 officers include John G. Bartram, vice president; Robert H. Dott, re-elected secretary-treasurer; and Kenneth K. Landes, re-elected editor.

Syracuse University and the Bureau of Nutrition, New York State Department of Health, will co-sponsor a **Community Nutrition Institute** June 16–28, planned for nutritionists, physicians, public health nurses, social workers, dentists, clinical dietitians, teachers of nutrition, and public health educators. Applications should be sent to Anne Bourquin, College of Home Economics, Syracuse University.

An **Educational Television Programs Institute**, a five-day seminar for approximately 60 college presidents and school superintendents, will be held at Pennsylvania State College Apr. 21–26. Milton S. Eisenhower is chairman of the Institute Committee, which consists of Armand L. Hunter, Ralph Steetle, Theodore M. Hesburgh, Francis Keppel, Mark C. Schinnerer, George E. Probst, and Arthur S. Adams. Carroll V. Newsom will direct the seminar, which is being underwritten by the Fund for Adult Education.

The first **International Congress of Dietetics** will be held July 7–11 in the Royal Tropical Institute, Amsterdam. Details will be furnished by Diane J. Ten Haaf, general secretary of the Executive Committee, 13 Pomonaplein, The Hague.

An **International Symposium on Problems of Desert Research** will be held in Jerusalem May 7–14. W. C. Lowdermilk, of the U. S. Department of Agriculture, will preside over the sessions. Other representatives from the U. S. will include J. B. Leighley, C. W. Thwaite, P. Meigs, and F. W. Went.

The **Pan-American Convention of Gastroenterology** will be held in Mexico City May 11–17. At the same time the **Mexican Gastroenterological Association** will hold its first national congress. Ramón Flores López, Oficina de Enseñanza e Investigación, Hospital General, Mexico 9, D. F., will supply details as to the program, for which papers are invited.

A **Symposium on Tropical Medicine** was held recently at Norwich, N. Y., under the auspices of Eaton Laboratories. J. M. Amberson, B. A. Cole, L. Hellerman, M. Natt, and A. Packchanian discussed the antimicrobial nitrofurans, a new chemotherapeutic means of treating tropical diseases.

The **Western Society of Naturalists**, meeting at Pomona College, elected the following officers for 1952: president, Arthur W. Martin; vice president, Martin W. Johnson; treasurer, Eugene N. Kozloff; member-at-large, Executive Committee, Philip A. Munz; and secretary, Garrett Hardin.

Technical Papers

Time Course of Fixation of N_2 by Excised Soybean Nodules[1]

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Experimental difficulties have been encountered by those seeking to demonstrate fixation of N_2 by excised nodules of leguminous plants. The earlier reports, reviewed by Wilson (*1*), and Allison, Hoover, and Minor (*2*), were based on gasometric analysis or analysis of nitrogen by the Kjeldahl method. As neither technique is particularly sensitive, the nodules were kept for relatively long periods before analysis; the possibility of fixation of N_2 by nonsymbiotic bacteria during such extended incubation could not be excluded. Much more sensitive and specific tests for fixation can be made with N_2^{15} as a tracer, but even such tests have been erratic, and the suspicion of fixation by contaminating organisms has remained (*3*).

Lincoln soybeans inoculated with *Rhizobium japonicum* were planted in the field and grown until nodules 3–5 mm in diameter were formed. The plants fixed N_2 vigorously, and the interior of the nodules was red with hemoprotein. Intact plants with the soil undisturbed around their roots were brought to the laboratory. The soil was dislodged from a few plants at a time, and their nodules were quickly removed and placed in Warburg flasks containing 0.5 ml of water. The flasks were attached to Warburg manometers, and 2 manometers at a time were quickly evacuated (*4*), flushed twice with He, and then filled with a mixture of 65% He, 20% O_2, 5% CO_2, and 10% N_2; the N_2 had approximately 20 atom % N^{15} excess. Three to 5 min elapsed from the time the nodules were removed from the plant until they were gassed with N_2^{15}. The flasks were shaken in a bath at 20° C, and pairs of flasks were removed at intervals. The nodules were ground immediately in a glass mortar with a few ml of 3 *N* HCl, centrifuged, and then washed with water by centrifugation. The combined extract and washings were subjected to Kjeldahl digestion, and the insoluble residue of the nodules was discarded. The ammonia in the digest was converted to N_2 and was analyzed for N^{15} with a mass spectrometer.

The data from 4 experiments, including 34 individual determinations, are summarized in Fig. 1; the values plotted are the averages of all the determinations at each time interval. Fixation of N_2 was obtained consistently, for only 1 sample (20-min harvest) had less than 0.05 atom % N^{15} excess. There was

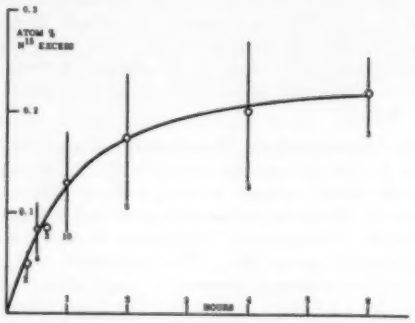

FIG. 1. Fixation of N_2^{15} into the soluble portion of soybean root nodules. Averages from all determinations are plotted. The vertical lines represent the standard deviation in the analytical results; the number of samples at each time interval is given at the base of these lines.

considerable variation among samples, as emphasis was placed on speed of treatment rather than on selection of nodules for uniformity; however, the averages define a smooth curve when fixation is plotted against time (Fig. 1). After 6 hr the fixation was less than twice that at 1 hr. The decrease in rate of fixation of N_2 with time suggests that an intermediate necessary in the fixation process was being depleted or that a necessary enzyme was being inactivated. In limited trials, the addition of 0.01 *M* solutions of neutralized (pH 6.2) α-ketoglutaric, oxalacetic, citric, acetic, succinic, or malic acids did not support fixation appreciably different from that observed with water only.

That the observed uptake of N^{15} was not the result of fixation by contamination organisms is attested by the speed of the fixation. More important, the rate of fixation decreased with time, whereas one would anticipate that fixation by contaminating agents should remain linear or increase with time.

The consistent fixation of N_2^{15} observed in these trials is attributed to: (*a*) the use of field-grown plants which usually fix N_2 more vigorously than those grown in the greenhouse; (*b*) the rapid exposure of the nodules to N_2^{15} after excision; (*c*) the analysis of only the soluble portion of the nodules. With conditions defined for obtaining consistent fixation, tests can be performed on the symbiotic N_2-fixing system without the difficulties attending the use of intact plants. Problems concerned with the nature of the materials supplied the nodule by the plant, and the influence of temperature, pH, pO_2, and pN_2 on fixation are all open to a simplified experimental approach.

[1] Published with the approval of the director of the Wisconsin Agricultural Experiment Station. Supported in part by a grant from the Rockefeller Foundation. The Consolidated-Nier mass spectrometer employed was a gift to the Graduate School from the Thomas Brittingham Trust Fund.

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A Saliva Test for Prenatal Sex Determination

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During the course of investigating some of the many ramifications of the Richardson Pregnancy Test (*1*) two rather interesting observations were made. The Richardson test depends upon the presence of free estrone, in contrast to bound or modified estrone or similar 17-ketosteroids in the female urine. This level of free estrone substances rises sharply soon after conception, the test being positive in as little as 2 weeks after conception, sometimes even before the first missed menstrual period. We were naturally interested in determining whether the free estrone level rose in other body fluids. Blood and urine have already been mentioned in Richardson's original article. We investigated such fluids as saliva, tears, and perspiration. The studies upon saliva yielded the results that are the subject of this report.

It was noted early in the study that in only some of the women who were in their sixth or seventh month of pregnancy did the Richardson test prove positive when the saliva was tested. In each of these cases, however, the test was positive on the urine. The apparent answer to the problem was forthcoming only after the delivery of the child. In nearly every case, the positive tests were associated with a male child, and most of the negative tests were associated with a female child. A detailed study followed. The results are presented in Table 1.

TABLE 1

Relation between Sex of Child and Reaction of the Mother's Saliva to the Richardson Test

	Positive	Negative
Males	218	3
Females	7	148

The precise nature of the substance responsible for the positive test is not known. It is believed that some androgenic substance is being identified, since, whereas a nongravid female normally yields a negative test, after the injection of testosterone or androsterone a strongly positive reaction results. The male saliva, spermatic fluid, and blood serum are all strong positive reactors.

The selective excretion of certain blood constituents through the salivary gland is well known. These findings illustrate a rather delicate selectivity of female salivary glands in their capacity to screen out certain female-associated hormones, but to allow certain male-associated ones to pass into the salivary fluid.

A detailed report of this project will be published in suitable medical journals. Because of their obvious practical nature, these findings are preliminarily reported here to allow early verification by others.

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Influence of Cobalt on Reproduction of Mice and Rats

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Reproduction studies with mice and rats kept on whole plant rations have been in progress in this laboratory for several years. In the first experiments, poor reproduction performance was observed (*1*), but later much more satisfactory results were obtained with a slightly modified diet (*2*). The only difference in the composition of the diets was that the salt mixture supplement used originally did not contain cobalt, whereas in the later experiments 0.2% $CoCl_2$ was added to the salt complement. Because of the apparent influence of this small amount of dietary Co on reproduction, the present study was undertaken.

The rats used were of the Sprague-Dawley strain, raised in our laboratory; the mice were of the same albino strain used in the previous experiments. The rats had been kept on a whole plant ration for at least 3 generations prior to the start of the present experiments, and the mice for at least 5 generations. The animals were kept on the basal ration in common cages until females became pregnant. These were put in single screen-bottomed cages and given the respective experimental diets and water *ad lib.* Litters were reduced by random selection to 6 and weaned at the age of 28 days.

The composition of the basal diet was: solvent-extracted soybean meal, 46; cornmeal, 46; sesame oil containing 0.2% percomorphum oil and 0.2% wheat germ oil, 5; salt mixture II USP, 2; thiamine, 0.3 mg; riboflavin, 0.3 mg; calcium pantothenate, 2 mg; pyridoxin, 0.2 mg; choline hydrocloride, 100 mg; nicotinic acid, 2 mg; folic acid, 0.025 mg; biotin, 0.01 mg; inositol, 10 mg; PABA, 25 mg. The diet has been analyzed by microbiological methods and found to contain about 0.5 μg/100 g of vitamin B_{12} activity (*2*). Cobalt was supplied in the diet by adding 0.2% $CoCl_2$ to the salt mixture, or in the drinking water in a concentration of 0.2 mg% of $CoCl_2$; when cobalt was injected, a 0.1% solution of $CoCl_2$ in physiological saline solution was used, of which 0.2 ml was injected in each female 2–6 days prior to giving birth. A total of 130 litters of mice and 64 litters of rats was used in the present study.

TABLE 1

REPRODUCTION OF MICE, KEPT ON A SOYBEAN-CORN RATION FOR SEVERAL GENERATIONS WITH AND WITHOUT COBALT OR VITAMIN B_{12} SUPPLEMENTS

Group	Supplements	No. litters born	No. litters dead	No. young weaned/ litters born	Wt of young at 28 days ($\pm$ S.E.$_m$)*	Wt change of mothers ($\pm$ S.E.$_m$)
1 (Control)	None	42	11	3.4	11.5 ± 0.377	-1.3 ± 0.341
2	4 mg% $CoCl_2$	20	1	4.7†	11.9 ± 0.482	$+0.7 \pm 0.459$†
3	0.2 mg% $CoCl_2$ in the drinking water	28	4	4.5†	11.7 ± 0.327	0 ± 0.408†
4	0.2 mg $CoCl_2$ injected i.p.	21	5	3.0	11.4 ± 0.375	-0.4 ± 0.650
5	4 µg% Vitamin B_{12}	19	2	5.0†	15.2 ± 0.364†	-0.5 ± 0.534

* S.E.$_m$ = Standard error of mean.

† Difference from control lot significant at 5% level.

The effect of cobalt on the reproduction of mice was studied in 4 series (Table 1). In the control group receiving the soybean-corn ration without added $CoCl_2$, the number of young weaned/litter born was 3.4. With the addition of 4 mg% $CoCl_2$ to the diet, the ratio of young weaned/litter born was 4.7. When the drinking water contained 0.2 mg% $CoCl_2$, the survival of the young was practically equal to the group receiving the Co supplement in the diet. Intraperitoneal injection of a single dose of 0.2 mg of $CoCl_2$ into the mother before giving birth did not significantly improve the survival of the young in comparison with the control group. Performance of the group receiving vitamin B_{12} in the diet was markedly better than that observed with the Co-supplemented diets.

The results obtained with rats (Table 2) were similar to those observed with mice. Only 1.4 young survived the 4-weeks weaning age out of each litter born on the diet without added Co, whereas on the Co-supplemented diet 1.75 survived, on the average. When Co was added to the drinking water, the corresponding value was 2.9. The mean weights of the young at the age of 28 days were 35, 54, and 55 g, respectively. The group receiving the $CoCl_2$ in the drinking water did as well as a group receiving the corn-soybean diet supplemented with 40 µg/kg of vitamin B_{12}. The supplementation also caused a significant weight gain of the mothers during the suckling period.

The difference between the numbers of litters dead in the control series and in those receiving a supplemented diet was never significant. This may be due to the fact that the feeding of the supplement was started only a few days before the birth of the litters.

The results of these experiments indicate that cobalt is of definite benefit for the reproduction of both mice and rats when they are kept on a whole plant ration low in vitamin B_{12}. The amount of Co present in the diet was not determined. The daily amount of Co derived from the supplement would be approximately 0.4 mg in the diet and 0.02 mg in the drinking water, respectively, for the adult female rats. Underwood (*3*) observed no improved growth in rats ingesting only 0.4 µg/day of Co when the diet was supplemented with this mineral. It has been concluded, therefore, that the normal need of the rat, if any, would not be higher than 0.4 µg/day of Co for growth. Our unsupplemented diet probably provided not less than this amount.

Lately it has been shown that Co forms part of the molecule of vitamin B_{12} (*4*) and that the addition of its salts to the culture medium stimulates the microbiological synthesis of this vitamin (*5*). It therefore seems possible that a stimulation of the intestinal synthesis of vitamin B_{12} is a likely explanation for the results described in this study. The fact that Co administered parenterally had no significant effect lends weight to this explanation, although the effect of prolonged and repeated administration of smaller doses of parenterally administered Co should be studied. It is known that ruminants have a dietary

TABLE 2

REPRODUCTION OF RATS, KEPT ON A SOYBEAN-CORN RATION FOR SEVERAL GENERATIONS WITH AND WITHOUT COBALT OR VITAMIN B_{12} SUPPLEMENTS

Group	Supplements	No. litters born	No. litters dead	No. young weaned/ litters born	Wt of young at 28 days ($\pm$ S.E.$_m$)*	Wt change of mothers ($\pm$ S.E.$_m$)
1 (Control)	None	18	11	1.4	35 ± 1.776	0 ± 6.99
2	4 mg% $CoCl_2$	12	8	1.75	54 ± 4.350†	16 ± 2.35†
3	0.2 mg% $CoCl_2$ in the drinking water	21	9	2.9†	55 ± 3.580†	11 ± 2.40
4	4 µg% Vitamin B_{12}	13	4	3.2†	59 ± 5.233†	24 ± 4.67†

* S.E.$_m$ = Standard error of mean.

† Difference from control lot significant at 5% level.

need for cobalt, the relation of which to the internal microbiological synthesis of vitamin B_{12} is still not clear (*6*). Klosterman *et al.* (*7*) have found that Co stimulates the growth of pigs fed a soybean-corn ration, whereas in a recent report (*8*) Co has been stated to be ineffective in speeding the growth of rats fed a diet low in vitamin B_{12} and containing iodized casein. The different techniques used in this study and in our experiments make a comparison of the results difficult, but it seems possible that the effectiveness of Co supplements depends on the special microbiological flora prevalent in the experimental animals.

It should be kept in mind that a considerable part of the human population subsists on diets very poor in animal products and therefore probably low in vitamin B_{12}. In these people the possible dietary need for cobalt should be considered.

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The Szilard-Chalmers Process in Solid Phosphorus Salts

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The formation of electron-pair bonds is well known in organic systems where a nucleus has a high kinetic energy as a result of a nuclear reaction. In inorganic compounds processes of this type are more difficult to recognize, as it is often possible to explain the formation of polyatomic ions as a result of secondary reactions (*1*). For this reason the formation of radioactive pyrophosphates in different phosphorus salts under neutron irradiation may be of some interest, as pyrophosphate formation does not take place in dilute aqueous solutions.

The solids listed in Table 1 were exposed to slow neutrons. The materials were dissolved in water containing pyrophosphate, orthophosphate, phosphite, and hypophosphite ions and the pyrophosphate was precipitated as zinc pyrophosphate or as cadmium pyrophosphate. From the figures in Table 1 it is evident that the analytical technique has very little influence on the results obtained. The determination of the activities of the different ions is possible because no exchange of phosphorus occurs between orthophosphate and pyrophosphate (*2*) or between orthophosphate and phosphite (*3*).

TABLE 1

Compound irradiated	Ion used for pyrophosphate precipitation	Fraction of total activity found in: Orthophosphate	Phosphate from pyrophosphate	Phosphite + hypophosphite	Phosphite + hypophosphite from pyrophosphate
$Na_4P_2O_7 \cdot 10\ H_2O$	Zn	0.36	0.43	0.19	0.02
	Cd	.35	.43	.20	.02
$Na_4P_2O_7$	Zn	.11	.47	.28	.13
	Cd	.10	.48	.32	.10
$Na_2HPO_4 \cdot 2\ H_2O$	Zn	.22	.18	.51	.08
	Cd	.22	.18	.52	.06
Na_2HPO_4	Zn	.20	.25	.46	.09
	Cd	.26	.22	.46	.05
$Na_2HPO_3 \cdot 5\ H_2O$	Zn	.10	.07	.77	.06
	Cd	0.13	0.06	0.70	0.10

It is evident that radioactive phosphorus might very well occur in other ions than those listed as carriers. Radioactive pyrophosphites, pyrophosphatephosphite and other types must clearly be taken into account, but it is impossible to add carriers for all these species. In our experiments part of these materials may have followed the pyrophosphate and part may have gone with the orthophosphate and phosphite fractions. Therefore not only the filtrates of the pyrophosphate were separated into an orthophosphate and a phosphite + hypophosphite fraction (by ammonium magnesium phosphate precipitation), but the pyrophosphates were dissolved, hyd.olyzed, and separated the same way.

The figures, which are (except in the first, second, and fourth lines) averages of two independent irradiations that were in good agreement, show clearly that in all cases an appreciable fraction of the total activity is present as pyrophosphate ions. There are indications that other radioactive ions containing two phosphorus atoms are formed, too.

It should be mentioned that if a pyrophosphate precipitate is not made but hydrolysis is performed, followed by a phosphate-phosphite separation, the fraction of the total activity found as pentavalent phosphorus is about 5% less than in Table 1. This may be due to absorption of carrier-free ion species or to exchange processes, but it does not detract from our general conclusions.

[1] We are glad to express our gratitude to the Nederlandse Organisatie voor Zuiver Wetenschappelijk Onderzoek and to the Stichting voor Fundamenteel Onderzoek der Materie for their support of this investigation. We also wish to thank the personnel of the Philips' cyclotron, who kindly performed the necessary irradiations.

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Closed Technique for Collection and Storage of Aliquots of Blood[1]

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To follow the aging process of the erythrocytes in various "preservatives," serial tests must be done and compared. A system for aliquoting and storing samples has been devised which is superior to present methods. The storage container is fabricated from a nonreactive, temperature-resistant plastic of polyvinyl chloride. It consists of a suitable length of 2-cm, lay-flat tubing, which is partitioned by sealing barriers transversely every 3 cm. The partitions have an opening about 1 cm in diameter along one side of the tube and serve to divide the container into 10 small compartments of about 5 cc each. In addition, a 50-cc compartment is formed at one end in which the blood is first mixed with the diluent. A three-way stopcock, treated to render its surface hemorepellent (*1*), is inserted into the collecting tube. This permits control of the stream of blood and the attachment of a syringe. In preparation, the entire unit (Fig. 1) is sterilized by exposure to saturated steam at 121° C for 30 min.

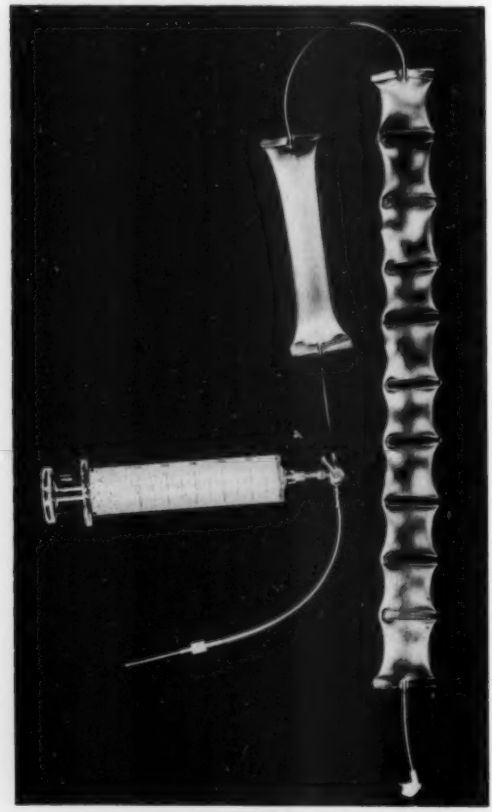

FIG. 1. Unit for collection and storage of aliquots of blood.

Blood is collected by gravity under sterile conditions in the large chamber, where a thorough mixing of blood and diluent from the syringe is accomplished. It is then permitted to enter the smaller compartments, where it is equally and automatically divided among them. The small passage in the partitions between chambers is sealed hermetically by dielectric heat. The chain of compartments may now be stored under identical environmental conditions. An aliquot can be removed periodically by dividing the sealed barrier with scissors to free a single compartment, leaving the remaining ones sterile and undisturbed.

[1] This work was done under a contract (DDRD-3) with the Department of the Army.

[2] Present address: Westminster Hospital, London, Eng.

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Some New Coordination Compounds of Thallium

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In 1909 the German chemist J. Gewecke became interested in the extensive agreement in the behavior between trivalent thallium and gold. This behavior became more apparent in some of the double chlorides of these two metals. He prepared a number of these double salts using the chlorides of divalent metals by allowing a solution of the component salts in water acidified with HCl to evaporate in a vacuum over concentrated sulfuric acid. These salts all corresponded to the formula $2TlCl_3 \cdot MCl_2 \cdot x\ H_2O$, where "$x$" was usually equal to 6 or 8. The similarity of the double salts of thallium and gold can be seen from Table 1 (*1*):

TABLE 1

$2TlCl_3 \cdot NiCl_2 \cdot 8H_2O$	$2AuCl_3 \cdot NiCl_2 \cdot 8H_2O$
$2TlCl_3 \cdot CoCl_2 \cdot 8H_2O$	$2AuCl_3 \cdot CoCl_2 \cdot 8H_2O$
$2TlCl_3 \cdot CaCl_2 \cdot 6H_2O$	$2AuCl_3 \cdot CaCl_2 \cdot 6H_2O$
$2TlCl_3 \cdot SrCl_2 \cdot 6H_2O$	$2AuCl_3 \cdot SrCl_2 \cdot 6H_2O$
$2TlCl_3 \cdot MgCl_2 \cdot 6H_2O$	$2AuCl_3 \cdot MgCl_2 \cdot 6H_2O$
$2TlCl_3 \cdot ZnCl_2 \cdot 6H_2O$	$2AuCl_3 \cdot ZnCl_2 \cdot 8H_2O$
$2TlCl_3 \cdot CuCl_2 \cdot 6H_2O$	

Notably missing from Gewecke's list are the double chlorides of barium chloride and mercuric chloride. There seemed to be no apparent reason for their nonexistence, and so their preparation was instituted in a method similar to that outlined by Gewecke for the previously prepared salts. A typical preparation

was as follows: To an acidic solution of 15 ml of water were added 0.006437 moles (4.0000 g) of thallic chloride and 0.01288 moles (3.4970 g) of mercuric chloride. The solution was stirred and then subjected to vacuum desiccation over concentrated sulfuric acid for a period of 24 hr.

In this preparation, as in all the others, the ratio of 2 moles of thallic chloride to 1 mole of the metallic chloride was utilized in deciding what weights to use.

The results were successful, yielding the two corresponding double salts. Both were very hygroscopic and as a result were kept in a vacuum desiccator or in an airtight container. The octochlorodithallate of barium was white in color and formed monoclinic crystals. Its formula is $2TlCl_3 \cdot BaCl_2 \cdot 6H_2O$. Monoclinic crystals were also very noticeable in the white double salt of divalent mercury. Its formula was proved to be $2TlCl_3 \cdot HgCl_2 \cdot 12H_2O$.

Although these new double salts of thallium may not have any immediate value, it is hoped that they will eventually serve to disclose more of the chemistry of the "duckbill" of the elements.

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Effects of High-Voltage Cathode-Ray Irradiation on Cottonseed

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High voltage x-rays and cathode rays have been shown to destroy pure cultures of molds and bacteria at minimum dosages of 1,000,000 and 1,500,000 roentgen-equivalents-physical (rep), respectively (*1*). This information suggested a practical application of ionizing radiations in the sterilization of foods and possibly seeds. Ground beef (*2*), fish slices (*3*), and other foods (*4*) have been irradiated, with the desired results. The reports on these foods indicated, however, that at dosages necessary for sterilization, enzymes in foods are slightly affected.

The effects of ionizing radiations have been recorded for many species of seeds. When applied to wheat (*5*), tomato (*6*), and mung beans (*7*) excessive irradiation has resulted in injury manifested as reduced and delayed germination, inhibition of growth, and, in some instances, complete loss of viability. Similar unfavorable reactions were observed when cottonseed was first irradiated with x-rays in 1933 (*8*). Since then, the sterilizing effects of combined ultraviolet and infrared rays have been noted (*9*).

This paper describes the adverse effect of high-voltage cathode rays on germination and growth of cottonseed when these rays are applied in dosages of sufficient strength to destroy associated microorganisms. Cathode rays were produced by a pressure-insulated, electrostatic generator of the Van de Graaff type, operating at 3 mev and capable of emitting a continuous supply of monoenergetic electrons in a magnetically focused beam (*10*). The dosages of cathode rays are expressed in terms of rep as described by Evans (*11*).

Two varieties of cottonseed were used in these investigations: a Stoneville 2B variety, crop year 1949, of 16.7% moisture and 2.24% free fatty acids contents; and a Delfos 651 variety, crop year 1948, of 11% moisture and 0.4% free fatty acids contents. The lot of Stoneville 2B seed was subdivided into 7 samples which were heat-sealed in polyethylene tubing. One sample was set aside as the control, and the remaining 6 received dosages of high-voltage cathode rays ranging from 500,000 to 3,000,000 rep in increments of 500,000 rep. The Delfos 651 variety was subdivided into 9 samples. One unirradiated sample was used as the control. The 4 remaining pairs of samples were irradiated at increasing dosages of cathode rays as follows: 500,000; 1,000,000; 1,500,000; and 2,000,000 rep, respectively. All treated lots of seed were irradiated in a single layer—the thickness necessary for effective exposure with a single dose. Irradiation was conducted from one side only.

The effects of ionizing radiations on cottonseed were measured in terms of moisture and free fatty acids contents, total and internal microbial populations, germinability, and growth. Methods used for the determinations of moisture and free fatty acids contents were those recommended by the American Oil Chemists' Society (*12*). The numbers of microorganisms per gram of whole seed were determined as published previously (*13*), except that the plating medium used for the growth of bacteria was tryptone glucose extract agar. Except where otherwise indicated, internal microflora were observed by planting 200 acid-delinted surface-sterilized (0.1% Ag NO_3) seeds from each sample on a modified Czapek's medium and recording the percentages of seeds showing visible evidence of the growth of microorganisms. In addition, the numbers of seeds germinating on the agar were noted. Separate germination tests were made according to the standard method (*14*); counts were taken on the sixth and ninth days, no additional sprouts being observed after the sixth day. Growth measurements of the sprouts were recorded as their lengths in millimeters at 9 days.

When applied to the Stoneville 2B variety of cottonseed, high-voltage cathode rays at 1,500,000 rep inactivated the microflora in the seeds (Table 1). Ex-

[1] Assistance in some of the analyses is gratefully acknowledged to E. A. Jensen, NCPA fellow, Mrs. J. S. Lambour, of the Protein & Carbohydrate Division, and to the Analytical & Physical Division, SRRL, New Orleans, La. Appreciation is expressed to James B. Dick, Delta Branch Experiment Station, Stoneville, Miss., for furnishing the seed used in these investigations.

[2] One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, ARA, USDA.

TABLE 1

EFFECT OF HIGH-VOLTAGE CATHODE RAYS ON INTERNAL INFECTION OF STONEVILLE 2B COTTONSEED

Dosage of cathode rays (rep)	Seeds* infected with			Total infected (%)
	Molds (%)	Bacteria (%)	Molds and bacteria (%)	
None	58	0	36	94
500,000	92	4	4	100
1,000,000	36	0	4	40
1,500,000	0	0	0	0
2,000,000	0	0	0	0
2,500,000	4†	0	0	4†
3,000,000	4†	0	0	4†

* Samples of 50 seeds each were used for the analyses, 5 seeds/plate.

† Probably a plate contaminant; molds were not of the same genera as appeared on the other plates.

posure to ionizing radiation at the dosages used did not increase the quantity of free fatty acids present or reduce the moisture content. It was impossible to gauge definitely the effect of cathode rays on viability, because of the extremely poor quality of this seed.

The effect of increasing dosages from 500,000 to 2,000,000 rep of high-voltage cathode rays on the Delfos 651 variety of cottonseed of good quality confirmed the data obtained for the Stoneville 2B seed with respect to microorganisms, free fatty acids, and moisture. Because few microorganisms were originally present in the Delfos lot, a dosage of 1,000,000 rep was successful in reducing the total count from approximately 1500 to less than 10 microorganisms/g whole seed. The lowest dosage—i.e., 500,000 rep—appeared to have destroyed the internal microflora in the few seeds found infected (1%).

Germinability decreased regularly as the dosage of ionizing radiation increased from 500,000 to 1,500,000 rep. Irradiation with 2,000,000 rep destroyed viability in all the seeds (Table 2). They did not germinate on agar at room temperature or between moistened towels at alternating temperatures of 20° and 30° C. Trends for germination on agar and rolled towels were similar though slightly higher on the agar because of the additional ions of nutritive value present in the medium (*15*).

TABLE 2

EFFECT OF HIGH-VOLTAGE CATHODE RAYS ON VIABILITY OF A DELFOS 651 VARIETY OF COTTONSEED

Dosage of cathode rays (rep)	Germination count	
	On agar* (%)	On rolled towels† (%)
None	47.0	66.7†
500,000	51.5	47.2
1,000,000	17.0	8.5
1,500,000	3.8	0.0
2,000,000	0.0	0.0

* Acid-delinted seed, surface-sterilized with 0.1% aqueous $AgNO_3$; 200 seeds/sample planted on Czapek's solution agar containing 0.1% KH_2PO_4 instead of K_2HPO_4 and 1% dextrose instead of sucrose, pH 5; stored at room temperature. Germinated seedlings were counted at 8 and 12 days; no change in count occurred after 8 days.

† Standard germination test: 4 × 100 seeds used except where value is marked †; in this case only 75 seeds were available.

All seedlings shown in Fig. 1 were selected as representative of the average length of the sprouts after 9 days. Growth of the seedlings was partly inhibited by the lowest dosage of high-voltage cathode rays, 500,000 rep, and completely inhibited by 1,500,000 rep (Fig. 1, seedlings 2 and 4, respectively). Fig. 1 (4 and 5) are dehulled seeds that had received dosages of cathode rays at 1,500,000 and 2,000,000 rep, respectively. These seeds had obviously imbibed water, were swollen, but did not germinate. They were typical of all the sound-appearing seeds on the towels (standard germination test).

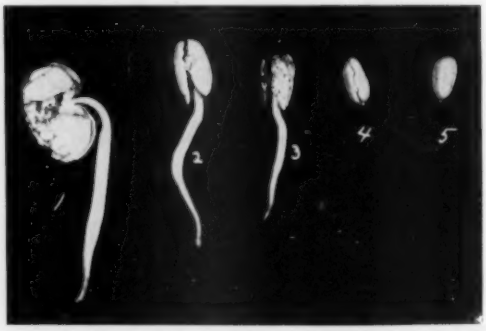

FIG. 1. Nine-day-old sprouts from cottonseed exposed to increasing dosages of high-voltage cathode rays, as follows: 1—none; 2—500,000 rep; 3—1,000,000 rep; 4—1,500,000 rep; and 5—2,000,000 rep.

As in the case of other materials, irradiation of cottonseed with high-voltage cathode rays significantly reduced the numbers of microorganisms present on and in the seed. This was accomplished without bringing about any changes in the moisture and free fatty acids contents of the seed, but was accompanied by a reduction in germination count and an inhibition of growth. The data showing increasing inhibition of germination and growth of cotton seedlings with increasing dosages of high voltage cathode rays—a pattern of response demonstrated by cottonseed and other seeds exposed to x- and γ-rays—suggest that one or more enzymes associated with the normal phenomena of germinating and growing have been inactivated by the rays.

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Influence of Nutrition upon Appearance of Tumors in *Tu^50j* Stock of *D. melanogaster*

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Tu^50j is a recessive mutation which appeared upon inbreeding Chicago wild *D. melanogaster*, and it contributes to the production of melanotic growths in the abdomen of the fly. Recently Burdette (*1*) has shown that *tu^48* reared on a medium deficient in yeast produced fewer tumors than those raised on re-yeasted medium, and since then Begg and Robertson (*2*), in an attempt to produce a completely synthetic medium for *D. melanogaster*, have reported that an unknown alkali-soluble factor from yeast must be present for growth. Hence, to determine the penetrance of *tu^50j* the influence of nutrition must be controlled. To be certain that all the nutritive factors (*2*)—chiefly amino acids and vitamins—came from the yeast and not the medium (usually cornmeal-molasses), a survey was made of yeasts that could live on a vitamin- and amino acid-free medium, as shown in Table 1. Included in this medium are the essential elements with which some of the yeasts are able to synthesize their own protoplasm. It is primarily a glucose and ammonium sulfate medium, plus several trace elements.

Twenty-seven species of yeasts from 14 genera were

TABLE 1

Vitamin- and Amino Acid-Free Medium

Ingredient	Amount
Agar	15 g
$C_6H_{12}O_6$	30 "
KH_2PO_4	1 "
$NaKC_4H_4O_6$	8 "
$(NH_4)_2SO_4$	2 "
$CaCl_2$	0.5 "
NaCl	.5 "
$MnSO_4$	.5 "
$MgSO_4$	.5 "
$FeSO_4$	0.5 "
H_2O	1000 ml

TABLE 2

Ability of Yeasts to Live on Complete Medium and on Vitamin- and Amino Acid-Free Medium

Yeast	Vitamin- and amino acid-free	M–Y Complete medium
Candida monosa	–	+
C. pseudotropicalis	–	+
C. mesenterica	–	+
C. sorbosa	+	+
Endomyces magnusii	+	+
Hansenula anomala	+	+
H. saturnus	+	+
Rhodotorula sanniei	–	+
R. aurantica	–	+
R. gracilis	+	+
R. glutinis	+	+
R. suganii	–	+
Pichia membranaefaciens	+	+
Debaryomyces globosus	+	+
D. membranaefaciens	+	+
D. disporus	–	+
D. matruchoti	–	+
D. guilliermondii	–	+
Kloeckera apiculata	–	+
Zygosaccharomyces lactose	–	+
Schizosaccharomyces versatilis	–	+
S. fragilis	–	+
Torulopsis utilis	+	+
Nadsonea fulvescens	+	+
Endomycopsis fibuliger	–	+
Geotrichium	+	+
Saccharomyces cerevisiae	–	+

tested for growth on the vitamin- and amino acid-free medium (Table 2); 12 were found capable of living on the minimal medium. The yeasts were transferred twice onto vitamin- and amino acid-free medium to make sure that none of the nutritive ingredients were carried over from the complete medium in which the yeasts were originally grown. To prevent overcrowding and to maintain a standard of comparison, a pair of flies from a highly inbred stock of *tu^50j* were placed on the minimal medium inoculated with yeast. It is believed that practically all the nourishment that the larvae obtained came from the yeast on the medium. The penetrance of *tu^50j* reared on yeasts that do require vitamins and amino acids on a minimal medium is presented in Table 3. It is quite evident from the results that *tu^50j* reared on yeasts growing in the minimal medium produced fewer tumors than those in *tu^50j* reared on *S. cerevisiae*, the yeast most commonly used in Drosophila work, grown on the cornmeal-molasses medium, for *S. cerevisiae* cannot grow on the minimal medium (Table 2). Hence, the larvae in the control series obtained some nourishment from the medium, for the substances essential for the growth of Drosophila are present both in the yeast and in the medium. There are probably as many variations in medium used to rear *D. melanogaster* as there are research workers who study them. It is difficult to separate the effect of the medium and *S. cerevisiae* upon the penetrance of *tu^50j*. However, one can compare the penetrance of the tumor gene when the flies

TABLE 3

PENETRANCE OF tu^{soj} WHEN REARED ON VITAMIN- AND AMINO ACID-FREE MEDIUM INOCULATED WITH VARIOUS YEASTS AND INCUBATED AT 24° C

Yeast	Percentage of *tu*	Total No. counted
Saccharomyces cerevisiae (Control on agar-cornmeal media)	4.7	12,521
Hansenula anomala	4.3	2246
Pichia membranaefaciens	2.1	2381
Candida sorbosa	1.9	2976
Nadsonia fulvescens	1.4	1443
Debaromyces globosus	1.3	1394
Hansenula saturnus	1.2	1603
Torulopsis utilis	1.1	1675
Rhodotorula gracilis	0	490
R. glutinis	0	310
Geotrichium	0	5

are raised on various yeasts that do not require vitamins or amino acids. One can state with assurance that tu^{soj} reared on *Torulopsis utilis* has less penetrance than when reared on *Hansenula anomala*. There is a significant difference between two yeasts in the same genus, *H. anomala* and *H. saturnus*, with respect to the penetrance of tu^{soj}. It may be the presence or absence of certain chemical factors in the yeast that influences tu^{soj} in production of tumors.

The number of flies produced per vial was greater with *S. cerevisiae* than with other yeasts on the minimal medium. Among the yeasts that can grow in the absence of vitamins and amino acids there is little difference with respect to total number of flies produced, except for *Rhodotorula* and *Geotrichium*. On these 2 yeasts the total number of flies was reduced, and *D. melanogaster* had difficulty in reaching adulthood.

Although wild *D. melanogaster* are attracted to the odor of fermenting substances, they can live on the nonfermenting yeast *Pichia membranaefaciens*, and also exclusively on any one of 8 other yeasts.

The above-described method of rearing *D. melanogaster* on a minimal medium, in which the yeast supplies all the essential nutritive substances, is useful in study of gene action and nutrition. The penetrance of tu^{soj} varies with the yeast used for nutrition. What are the chemical differences between the yeasts that give rise to this variation? Will other genes show variable gene penetrance and expressivity when the fly is grown exclusively on the minimal medium and with yeasts which require no vitamins or amino acids?

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Prolongation of Blood Clotting Time in the Dormant Hamster[1]

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It has been shown (*1*) that in ground squirrels of the species *Citellus columbianus* and *C. parryi ablusis* the time necessary for the blood to clot is prolonged when they are in a dormant state. These squirrels both hibernate during the cold winter months and estivate during the summer months. It was considered desirable to know whether prolongation of blood clotting time was peculiar to them or whether it occurred in other mammals, particularly those that hibernate but do not estivate.

TABLE 1

Active				Dormant			
No. animals tested	Clotting times			No. animals tested	Clotting times		
	Max	Min	Av		Max	Min	Av
11	10′17″	2′03″	4′52″	4	156′00″	14′00″*	50′45″

* Hamster was breathing rapidly and was not in "deep" hibernation.

The golden hamster of the species *Mesocricetus* (*Cricetus*) *auratus* was chosen as a convenient animal for experimentation, since it can be induced to assume dormancy in the laboratory if the temperature of its surroundings is lowered. The clotting times of the blood of both active and dormant hamsters were determined by using Lee and White's technique. Since superficial blood vessels are small in these mammals, it was necessary to obtain blood samples by cardiac punctures. The results of the experiment are shown in Table 1.

It is apparent from these data that prolongation of blood clotting time is not restricted to dormant ground squirrels but also occurs in dormant hamsters.

It was pointed out in (*1*) that the prolongation of clotting time in ground squirrels is apparently an adaptation to the dormant state, for then the blood flows very slowly and some mechanism is therefore necessary to prevent the formation of thromboses. This same interpretation may also apply in the case of the torpid hamster, whose heart rate and blood flow are similarly reduced It may very well be that this lengthening of the clotting time of the blood is characteristic of those mammals that periodically assume a state of dormancy.

[1] Acknowledgment is made to the Air Force under contract AF33(038)-18509 for aid and assistance in making this study.

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Manuscript received October 19, 1951.

Book Reviews

Photosynthesis and Related Processes: Spectroscopy and Fluorescence of Photosynthetic Pigments; Kinetics of Photosynthesis, Vol. II, Part 1. Eugene I. Rabinowitch. New York: Interscience, 1951. 608 pp. $15.00.

The trend in books concerned with complex matters seems increasingly to be toward those written as a group effort by an assortment of specialists, under the generalship of an editor-in-chief who may or may not have a command of the subject as a whole. This trend, however, has not yet reached the field of photosynthesis. E. I. Rabinowitch is his own panel of experts surveying, as he does in *Photosynthesis and Related Processes,* the entire field, from history to descriptive biology to the quantum relations of the process—all with equal display of virtuosity.

The present volume, following its predecessor by six years, is concerned with the spectroscopy of the photosynthetic pigments and with the kinetics of the phytosynthetic process. So bulky did the materials on kinetics become that Volume II has been subdivided, more or less arbitrarily, into two parts. The present Part 1 of Volume II takes us only through the carbon dioxide and light intensity aspects of photosynthetic kinetics. Discussion of temperature, time effects, etc., will follow in Part 2.

As was the case with Volume I, a prodigious amount of information is presented—information that is critically evaluated and, in general, beautifully integrated into a lucid and well-defined picture. The reader is, in fact, continuously impressed by the ability of the author to carry through the evaluation and organization of scattered and miscellaneous information into a comprehensive and coherent picture.

Volume II deals first with the photochemistry of the chlorophylls, related porphyrins, and of the other plastid pigments. This is followed by a detailed discussion of the factors that influence light absorption by the chloroplast pigments, as well as the partition of energy among the several pigments in the cell itself. The physiological significance of pigment fluorescence is treated *in extenso.*

The study of the kinetics of photosynthesis is one of the classic approaches to the subject. Although this approach has, in the past, yielded much information of value, it cannot give us such detailed insight into the mechanism of photosynthesis as is obtainable from the studies of the pathways of energy and of carbon, as these pathways may now be studied with isolated chloroplasts or with isotopic carbon, respectively.

Concerning the 6 chapters on the kinetics of photosynthesis in the present volume the author says:

> The analysis of kinetic data, to which many pages in this volume are devoted, now seems somewhat like an attempt to reach a treasure chamber by drilling through steel walls while keys have been found to unlock the door.

Nonetheless, the reviews of carbon dioxide and of light effects in photosynthesis are not only the most comprehensive, but also the most readable, that have appeared to date. The discussions concern not only *Chlorella* in Warburg flasks but also higher plants under natural conditions, and will be of interest and value not only to workers in the field of photosynthesis, but also to ecologists and horticulturalists.

Some 56 pages of the volume are devoted to a discussion of the maximum quantum efficiency of photosynthesis. One finds no dogmatic conclusion but is left, nevertheless, with the rather definite impression that the maximum efficiency is 10 quanta used per mol of O_2 released.

Volume II, Part 1, of "Photosynthesis" is a thorough, readable, and often exciting member of a series that will be the standard reference work in the field for many years to come. It is wholeheartedly recommended to all biologists and chemists as excellent (but scarcely light) reading.

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Ecological Animal Geography (Hesse). 2nd ed. W. C. Allee and Karl P. Schmidt. New York: Wiley; London: Chapman & Hall, 1951. 715 pp. $9.50.

It was with Hesse's blessing that Allee and Schmidt, in the early thirties, undertook the translation and revision of his *Tiergeographie auf oekologischer Grundlage* (Jena: Fischer [1924]), and the resulting *Ecological Animal Geography* quickly became recognized after its publication in 1937 as the standard book on the subject.

The second edition of "Hesse, Allee, and Schmidt" follows the plan of the 1937 edition, practically chapter by chapter, with the greater part of the earlier subheads and illustrations also being retained. The text, however, shows a substantial amount of new material (an expansion by about 10%) and sufficient recasting of the old to cover the more recent progress in some modern ecological fields. Additions include treatment of territoriality in vertebrates, migration flyways of North American waterfowl, and the "phase theory" with regard to swarming locusts. Whether dealing with old or new subject matter, the revisers have worked to integrate our existing knowledge and to give the reader an interesting, understandable, and accurate over-all picture.

The present edition is comfortable to read, because of the way in which it is written and because of the confidence one feels in its authorship. Minor statements may be challenged—such as the puma hunting deer *only* at times of deep snow (p. 496) and monkeys *never* wandering farther than 4–6 km from water (p. 545)—but I don't think these detract importantly from the outstanding values of the book, which is indeed a scholarly and unique product.

The scope is patently designed to leave the reader with a balanced view concerning distribution, living requirements, and adaptations of animals over the world. Although it may be classed primarily as a textbook for college courses in ecology, *Ecological Animal Geography* always has been a good reference for mature biologists looking for basic information outside their specialties, and the second edition should thus be better still. Especially useful from the standpoint of easy orientation of ecological complexities are the reviews of faunal types characteristic of given habitats.

The book should instill in its readers a wholesome appreciation of life as a phenomenon, of the great push of organisms to occupy essentially every habitable place that they can reach, to live or try to live somehow from abyssal ocean depths to mountaintops, in caves, brine lakes, deserts, and other restricted niches to the lushest of prairies, marshlands, estuaries, and rain forests.

PAUL L. ERRINGTON
Agricultural Experiment Station
Iowa State College

Principles of Geology. James Gilluly, Aaron C. Waters, and A. O. Woodford. San Francisco: Freeman, 1951. 631 pp. $5.75.

Principles of Geology is one of the most stimulating books of its kind to appear in recent years, yet this reader finds it difficult to evaluate.

A nice balance of subject material is achieved although those following a more conventional approach will find an unorthodox lack of emphasis on geomorphological aspects. In general the organization and approach used by the authors seem well designed for their stated purpose of acquainting the reader with the *fundamentals* of geology. Their task is lightened by liberal use of simple analogies aimed to help the reader bridge the gap from the familiar to the new. Further, the numerous examples referred to in the text are excellent, and the technique of summation used following each chapter is to be commended. The book benefits also from a pleasing format, numerous excellent line drawings, and well-selected photographs.

There is, however, an unevenness in the quality of writing and organization that detracts from an otherwise exceptionally fine text. The style of writing is highly variable, sometimes reaching the extreme of an incomplete sentence (p. 323).

On the whole, this reviewer is in complete accord with the authors' principle of providing a background of allied fact for the geologic process under immediate discussion. Occasionally, however, the wealth of detail may obscure the immediate objectives.

The insertion of a chapter on ground water between those on glaciation and deserts (essentially wind erosion) seems to interrupt the development of the land surface erosion theme. The chapter on ground water might more suitably follow a discussion of deserts.

Again, definitions of textures of metamorphic rocks appear in Chapter 5, whereas the detailed description is treated in Appendix IV. It would have improved the organization of the chapter to have treated this group in entirely the same fashion as the igneous and sedimentary rocks. Furthermore, though Gilluly, Waters, and Woodford are meticulous in providing background material elsewhere in the text, by contrast they are quite parsimonious with the material presented in Appendix IV covering "Identification of Rocks."

The above are, at worst, minor criticisms. The book is stimulating, although on occasion ponderous; it is teachable, if my experiment in handing it to a complete novice is any guide; and it is nicely objective in its approach.

Some persons may question whether *Principles of Geology* is altogether suited to a group with no scientific background. (I rather think it would stimulate them to rise to its level.) There is no question but that it is to be recommended for the advanced undergraduate.

The authors and publishers are to be congratulated on a fine piece of work.

JANET M. AITKEN
Department of Geology and Geography
University of Connecticut

Scientific Book Register

Where Winter Never Comes: A Study of Man and Nature in the Tropics. Marston Bates. New York: Scribners, 1952. 310 pp. $3.50.

The Genera of South African Flowering Plants. Botanical Survey of South Africa, Memoir No. 25, 1951. Rev. 2nd ed. E. Percy Phillips. Order through Government Printer, Pretoria, South Africa. 923 pp. £2.

Phosphorus Metabolism, Vol. I. A Symposium on the Role of Phosphorus in the Metabolism of Plants and Animals. Sponsored by the McCollum-Pratt Institute of The Johns Hopkins University. William D. McElroy and Bentley Glass, Eds. Baltimore: Johns Hopkins Press, 1951. 762 pp. $10.00.

Navaho Grammar. American Ethnological Society Pub., Vol. XXI. Gladys A. Reichard. Locust Valley, N. Y.: J. J. Augustin, 1952. 393 pp. $7.00.

Transmitting Valves: The Use of Pentodes, Tetrodes and Triodes in Transmitter Circuits. J. P. Heyboer and P. Zijlstra. Eindhoven: Philips' Technical Library, 1951. U. S. distrib.: Elsevier Press, Houston. 308 pp. $6.25.

Handbook of Dangerous Materials. N. Irving Sax, with assistance of M. J. O'Herin and W. W. Schultz. New York: Reinhold, 1951. 848 pp. $15.00.

Cancer Cytology of the Uterus: Introducing a Concept of Cervical Cell Pathology. J. Ernest Ayre. New York: Grune & Stratton, 1951. 407 pp. and 362 figs. $14.50.

Manufacturing Processes. 3rd ed. Myron L. Begeman. New York: Wiley; London: Chapman & Hall, 1952. 608 pp. $6.00.

Quantum Theory of Matter. John C. Slater. New York–London: McGraw-Hill, 1951. 528 pp. $7.50.

Synthetic Resins and Allied Plastics. 3rd ed. R. S. Morrell and H. M. Langton, Eds. New York: Oxford Univ. Press, 1951. 747 pp. $10.00.

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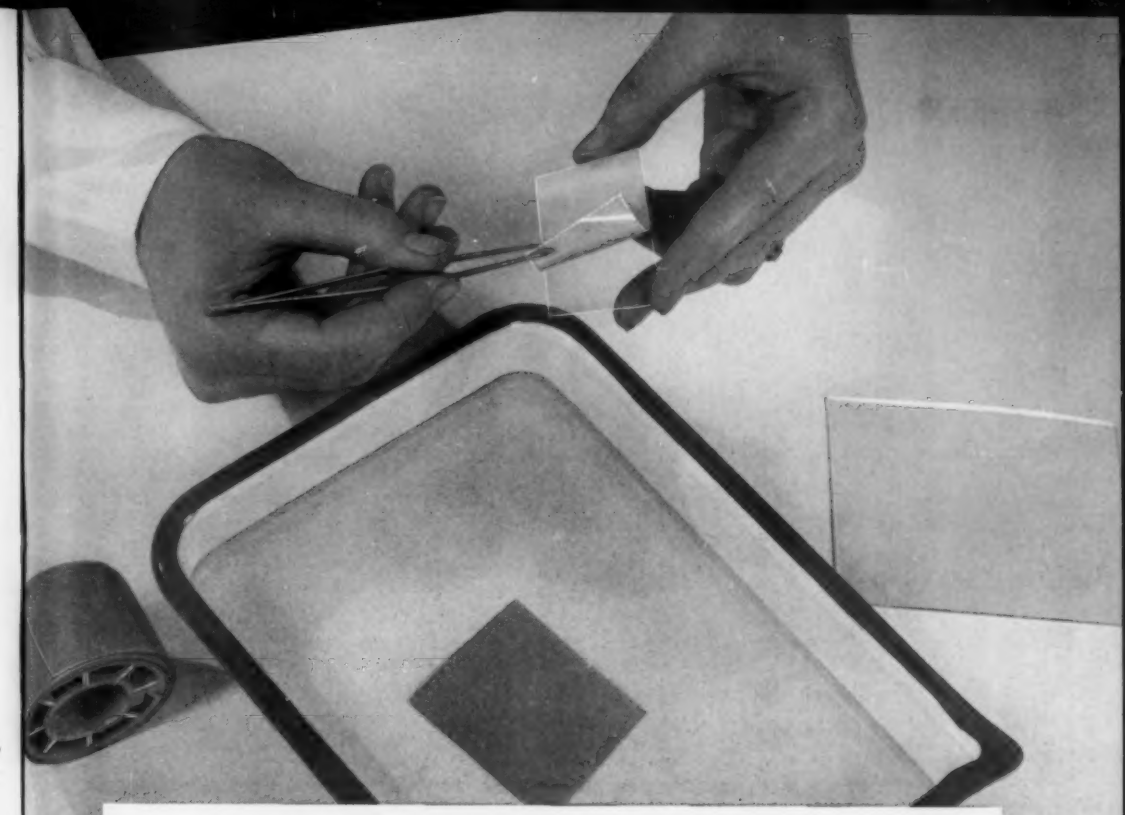

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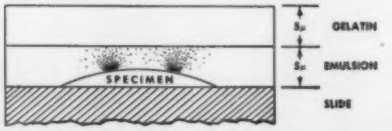

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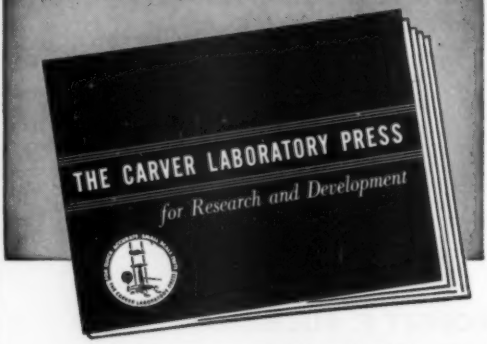

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Air Flow through Conventional Window Openings. Research Rept. No. 33. Theo R. Holleman. Nov. 1951. 45 pp. Illus.; ***Lime Stabilization of Clay Soil.*** Bull. No. 124. Bob M. Gallaway and Spencer J. Buchanan. College Station: Texas Eng. Expt. Sta., 1951. v + 57 pp. Illus.

Annotated List of Birds of Barro Colorado Island, Panama, Canal Zone. Smithsonian Inst. Misc. Collections, Vol. 117, No. 5. Eugene Eisenmann. Feb. 1952. 62 pp.; ***Chippewa Child Life and its Cultural Background.*** Bur. of Am. Ethnology Bull. 146. Sister M. Inez Hilger. xiv + 204 pp., 31 plates. 75¢; ***Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for 1951.*** Pub. No. 4056. Washington, D. C.: Smithsonian Institution, 1951. 55¢.

The Anthropology of Iraq, Vol. XLVI, No. 1. ***The Northern Jazira.*** Henry Field. 116 pp., 49 figs. $6.50; ***Mammals Found at the Awatovi Site*** and ***Post-Cranial Skeletal Characters of Deer, Pronghorn, and Sheep-Goat with Notes on Bos and Bison,*** Vol. XXXV, No. 3, Pts. I and II. Barbara Lawrence. Cambridge, Mass.: Peabody Museum, 1951. 44 pp. Illus. $2.00.

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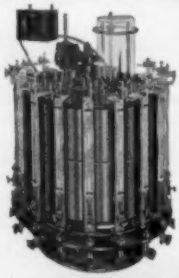

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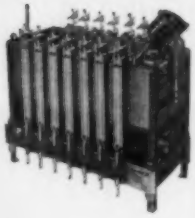

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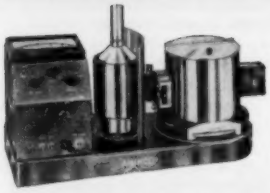

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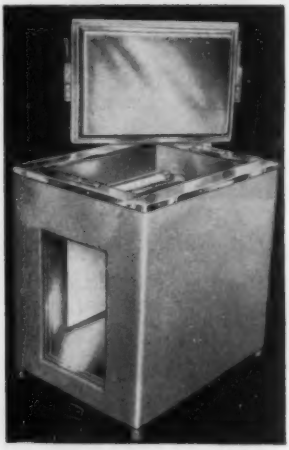

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Mar. 24–27. American Chemical Society. Buffalo, N. Y.

Mar. 24–27. American Mosquito Control Association (Annual). Salt Lake City.

Mar. 24–28. National Power Show, National Association of Power Engineers. Hotel Sherman, Chicago.

Mar. 25–27. The Institute of Metals (Annual). London.

Mar. 26–28. American Pharmaceutical Manufacturers' Association. The Greenbrier, While Sulphur Springs, W. Va.

Mar. 26–28. American Power Conference (Annual). Sherman Hotel, Chicago.

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Chemist; Ph.D. (major, organic chemistry; minor, microbiology); several years' teaching experience; four years, research fellow in biochemistry and pathology; eight years, director of research, large industrial company; for further information, please write Science Division, Medical Bureau (Burneice Larson, Director) Palmolive Building, Chicago. X

June Ph.D., Endocrinology, physiology, biochemistry, desires academic position affording research opportunities. Teaching experience. Box 118, SCIENCE. X

Microanatomist: Ph.D., over 5 years experience in medical school teaching; desires to relocate in medical school teaching and research. Box 119, SCIENCE. X

Microbiologist—Ph.D. Age 25. Experienced in antibiotic work and microbiological fermentation, desires research or teaching in University or industry. Box 117, SCIENCE. X

Mycologist; Ph.D., five years experience supervising bacteriological biologics production and research, six years antibiotic research, formal training and experience in teaching; experience not concurrent. Desires teaching and/or research position. Box 115, SCIENCE. X

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Tissue Culturist wants position with biochemist or enzymologist interested in the study of development of malignancy in vitro by altering enzyme systems of cells. Box 120, SCIENCE. X

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Wanted: Anatomist interested in teaching and research in human embryology and/or neurology at state institution located in large medical center in southwest. Ph.D. preferred. Salary and rank open. Can interview at Anatomist Meetings. Dr. Ira R. Telford, Prof. of Anatomy, Univ. of Texas School of Dentistry, Houston, Texas. 3/14

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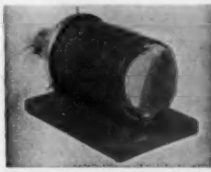

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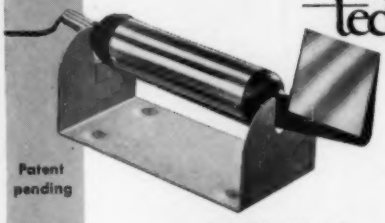

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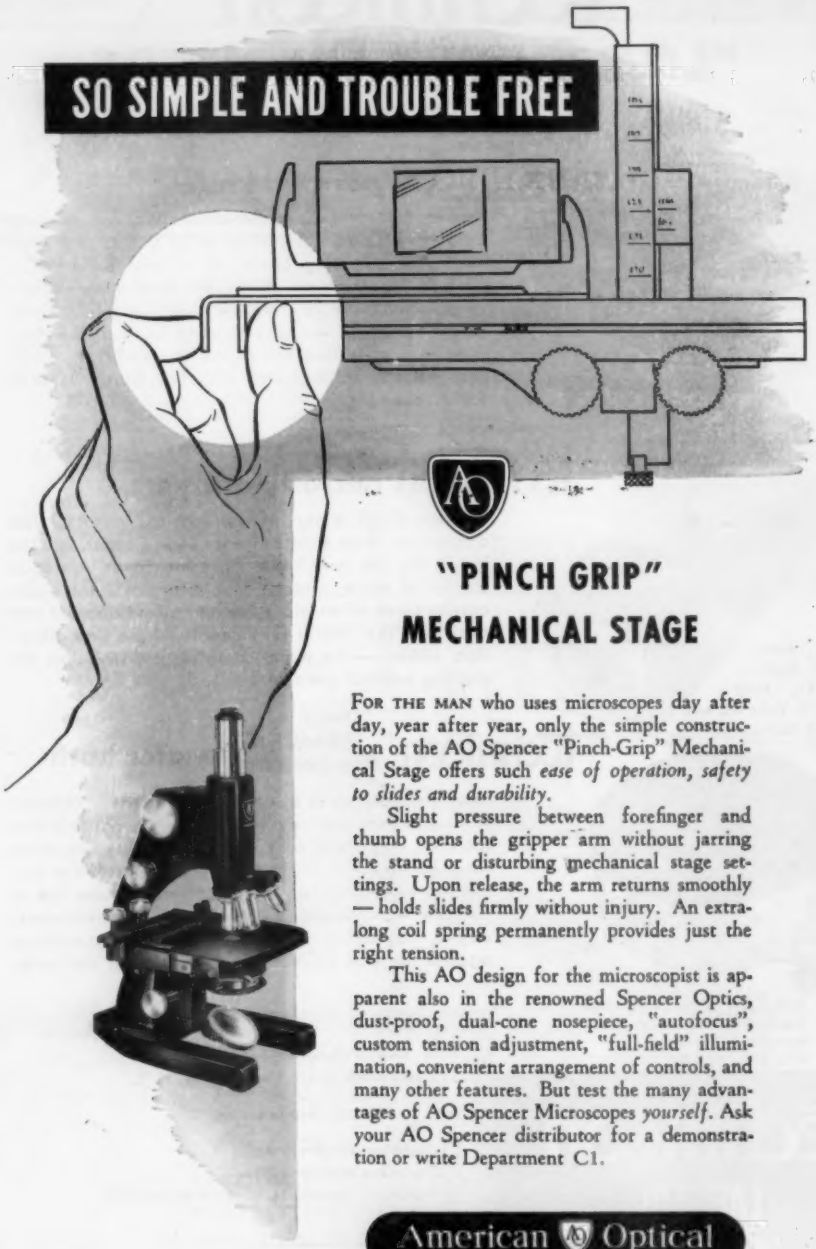

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